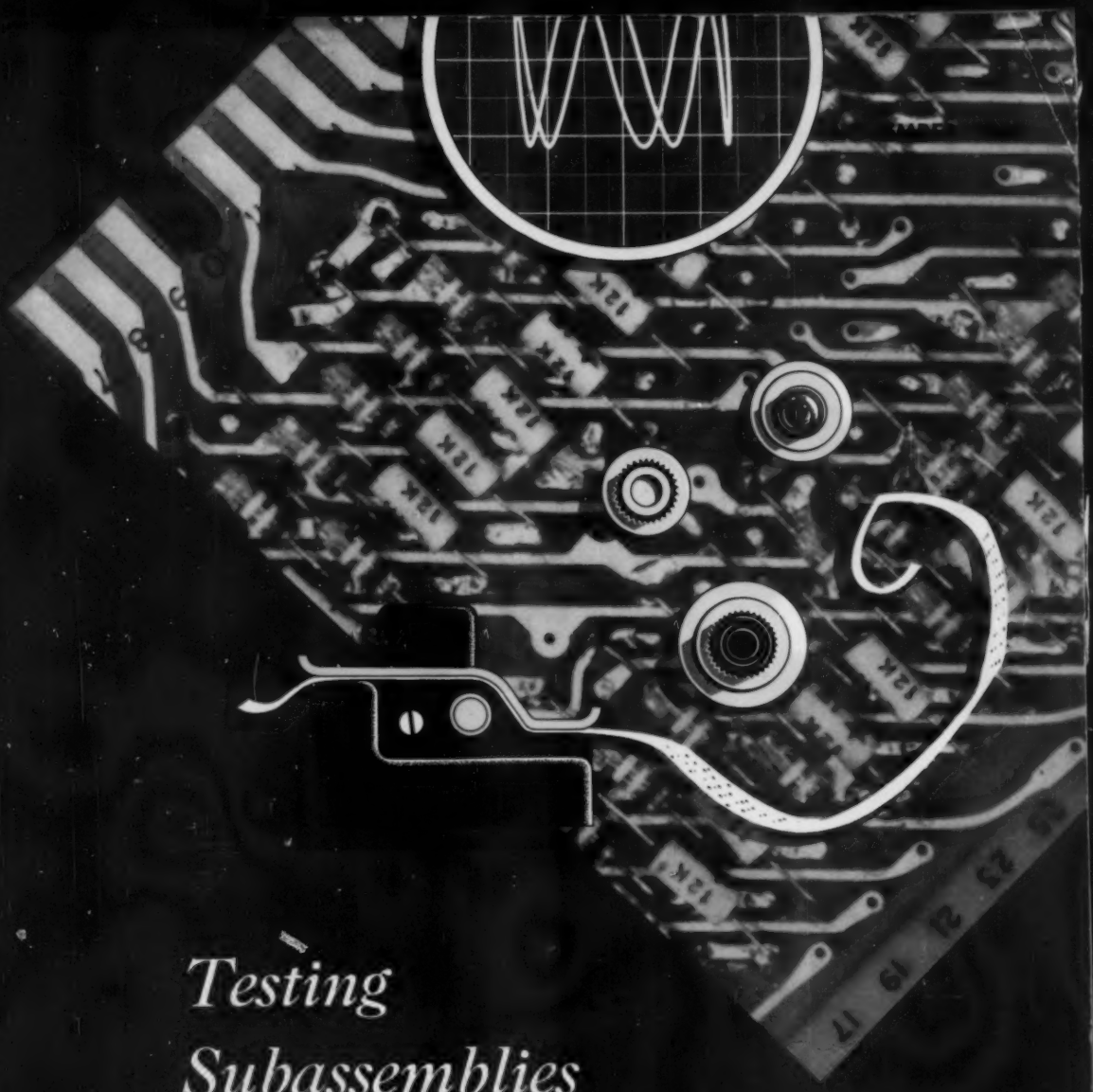
AUTOMATION



Testing Subassemblies

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Process Analysis and Machine Procurement
- Coping Speed with Cams
- Timing Devices for Automatic Control
- Temperature Controls—Selection and Application

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A PENTON PUBLICATION

At left, Leslie Edgcomb, Jr., director of purchases for Edgcomb Steel, looks on as Joseph Drexler, vice president and general manager, checks the width of a slit strand.

Edgcomb Steel expands product range and speeds delivery with Wean slitting line

Edgcomb Steel Company, like so many other metal service centers, has noted a continuing trend toward the purchase of metals in coil form by its customers. The increasing demand for aluminum, stainless steel and carbon steel in this form is due to the lower costs realized by metal users through coil processing. Edgcomb has equipped three of its four plants with slitting lines to satisfy this requirement.

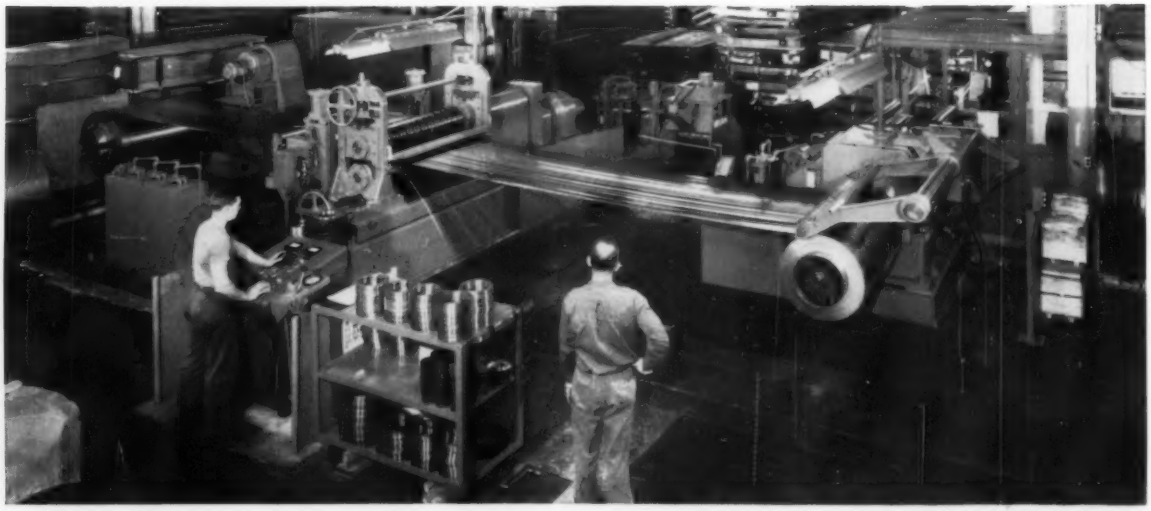
The firm's York plant was set up in 1954 around the Wean slitting line illustrated. Coils, stocked in standard widths up to 48" and gauges ranging up to .125", can be slit and side-trimmed quickly and economically to fill customer's orders for narrower widths. Two sets of knives, one for aluminum and one for steel, equip the line to process both metals at speeds up to 800 fpm.

Wean is a leader in the design and construction of coil processing equipment. Whether your operation involves slitting, shearing or stamping metal from coils, Wean can supply the equipment to do the job quickly, accurately and economically. A comprehensive discussion of these operations is contained in a brochure entitled, "Coil Processing." We will be glad to send you a copy if you will send us your request on business letterhead.

WEAN EQUIPMENT CORPORATION
22800 Lakeland Boulevard
CLEVELAND 17, OHIO

WEAN

Wean slitting line at Edgcomb Steel's York plant makes 22 cuts in mild steel on this run for a customer who will form tubing from the slit coils.



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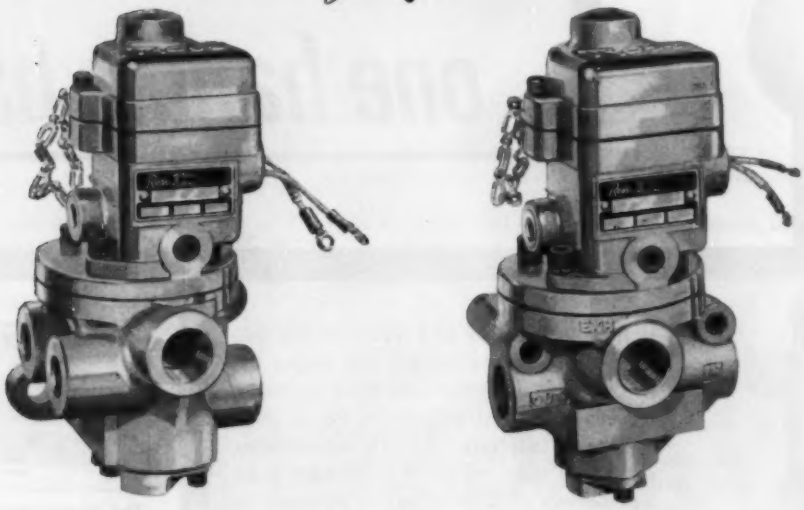
Ross

Proudly presents



THE NEW "HEADLINE" SERIES

A complete new series of inline valves, sizes one-quarter inch through one and one-half inch, straightway, 3-way and 4-way. These valves, size for size, will operate faster, longer, and provide greater capacity than any other valves we have been able to find.

When the price, quality and performance and Ross reputation are taken together in evaluating this series, it represents probably the best valve value available today. Before you specify any valve after today, you owe it to yourself to look into the "headline" series. Write for full information.

Ross OPERATING VALVE COMPANY

131 EAST GOLDEN GATE AVE. • DETROIT 3, MICHIGAN

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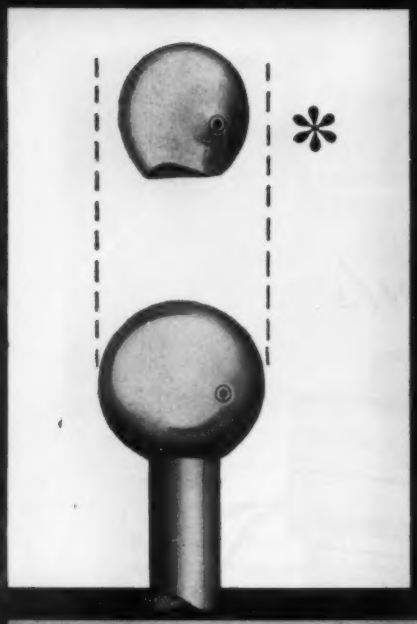
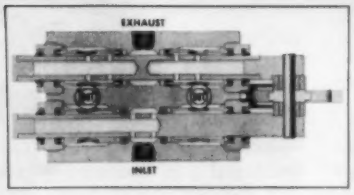


after 17 years... replacement parts

one handle ball!

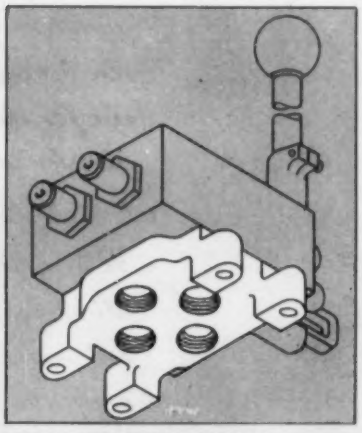
Human hands wore this metal handle ball to a fraction of its original size before the customer returned the valve to us for reconditioning. This high pressure hydraulic valve performed faithfully for nearly two decades with only such minor maintenance as replacement of "U" packing. We replaced the handle ball, repacked it, cleaned it up, and sent it back. This kind of trouble-free service is typical of Hunt hydraulic valves.

¾" MS-551-N4



The Higher the Pressure The Tighter the Seal

Cross-section view shows Hunt system of "U" packing as opposed to "metal to metal". "U" packing provides zero leakage on water hydraulic service.



Sub-Base Mounting Simplifies, Speeds Up Maintenance

New sub-base mounting is now available on all Hunt hydraulic valves. Easy, quick replacement for maintenance with no disconnecting of pipes.

HUNT HUNT VALVE COMPANY DIVISION OF IBEC SALEM, OHIO

Quick-As-Wink AIR & HYDRAULIC CONTROL VALVES

NOVEMBER 1960
Vol. 7 — No. 11

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Manufacturing Operations

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Penton Building, Cleveland 13, Ohio

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automation outlook

EVOLUTION FOR LARGE AND SMALL

". . . A large portion of the investment in automation is a quiet evolutionary effort, that goes on unnoticed and unpublicized . . . . this evolutionary automation—the use of electronic controls to modernize, improve and update existing plants—is increasing production volume, improving quality, and lowering production costs . . . . these evolutionary techniques can achieve important savings in both large and small scale installations, and can therefore be employed by both large and small businesses . . . ."—*B. Barth, vice president, Giannini Controls Corp.*

CONSIDERING INVESTMENT PROPOSALS

". . . lowering the cost of manufacturing operations by applying advanced automatic methods and equipment raises the question not of 'whether?' but of 'to what degree?' . . . . Four aspects of a proposed change must be favorable to make an investment a good risk . . . . The product must be ready; the equipment must be practical; the results must be real; and the change must fit into future plans. . . ."—*H. A. Leone, manager, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp.,* *see page 62.*

WORKING ON THE RAILROADS

". . . maximum utilization of the complete railway plant can best be accomplished by the application of automatic equipment wherever economically justified. And by careful planning each step will bring the railroads closer to the tremendous potential of operating and economic advantages inherent in automatic operation . . . ."—*J. W. Hansen, manager sales promotion and advertising, Union Switch & Signal Div., Westinghouse Air Brake Co.*

REFINERY GOAL

". . . the goal of our refineries is full-fledged automatic control, and what we would like to see is a system of instruments and computers into which we could feed market requirements. From there on, the computers would calculate the materials that would be required and send signals to individual processing units as to what they should do to make these products in the most economical fashion. Each unit would then follow instructions through its own system of continuous analyzers, sensing mechanisms, computers, and feedback control units. . . ."—*E. D. Reeves, vice president and director, Humble Oil & Refining Co.*

STILL GROWING

". . . the electronic automation business—built around a computer—will have the greatest growth of our economy during the 1960's and have a total industry volume of more than twenty-billion dollars in ten years, an increase of more than 300 per cent over last year's estimated industry volume of some six billion dollars. An industry growing that fast is going to require the employment of many additional people . . . ."—*C. C. Lasher, general manager, Computer Dept., General Electric Co.*

AUTOMATION

Penton Building, Cleveland 13, Ohio
Main 1-8260

ROGER W. BOLZ
Publisher-Editor

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BPA NBP

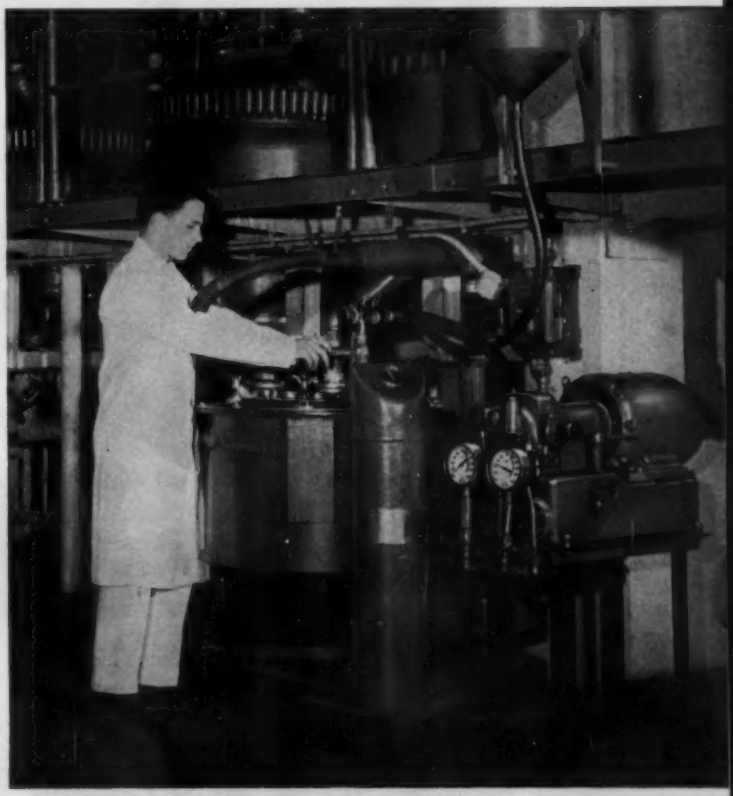
. . . Fluid Power news

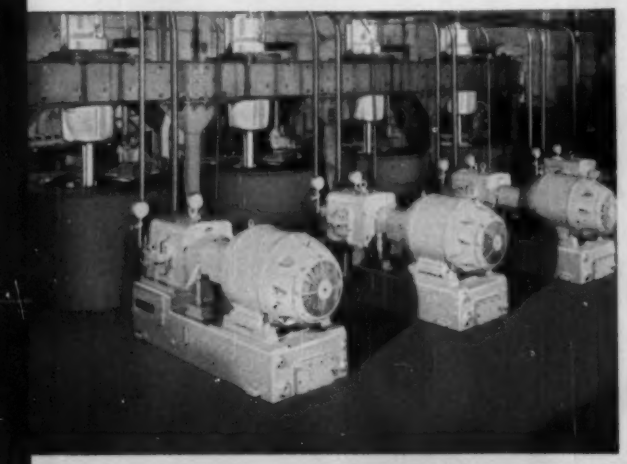
REPORT NO. 11,103 "ANY-SPEED" DRIVES CUT EXTRACTION TIME

OILGEAR "ANY-SPEED" CENTRIFUGE DRIVES STEP UP PRODUCTION 33 TO 85%

Only OILGEAR provides "ANY-SPEED" for efficient LOADING . . . efficient WASHING . . . efficient EXTRACTION . . . efficient UNLOADING

Production increases and profitable gains in centrifuging, without redesign of machines, resulted solely from changing to Oilgear "ANY-SPEED" Drives. Simply by giving the laboratory and the production operator dependable, positive Oilgear drives to shade the speeds of centrifuges experimentally — and easily discover the optimum centrifuge speed for each operation and product, cycle time was cut 33 to 85%. With Oilgear "ANY-SPEED" Drives, users get convenient selection of extremely slow speeds for easier loading . . . quick or gradual acceleration to the right washing speed . . . quick or gradual acceleration to the right high extraction speeds . . . quick or gradual deceleration to positive slow speeds for easier unloading. Just the right speed (selected at will) for every operation. There's built-in, automatic protection against overload. Full torque is available at all speeds. Power input is only in proportion to speed and resistance met. For more efficient separation, clarification, classification, thickening, dewatering, impregnating, enameling, galvanizing, painting, wringing, washing, rinsing and drying of products by centrifuging, you need Oilgear "ANY-SPEED" Drives.





FOUR CENTRIFUGES IN POWDER PLANT

Explosive and flammable material is processed with utmost safety when using these four Oilgear 60 hp "Any-Speed" Drives. Through convenient remote controls, these centrifuges accelerate to 300 rpm for loading, to 900 rpm for 15-minute centrifuging, then decelerate to 70 rpm for "plowing." Unloading is automatic. Other speeds selected at will.

Controlled Centrifuging in Laboratory & Production

A leading house in pharmaceutical, drug and chemical field found the flexibility of an Oilgear "ANY-SPEED" Drive on their laboratory centrifuge very essential for progressive product research. For optimum product production, five of their large centrifuges are equipped with Oilgear "ANY-SPEED" Drives.

You'll find Oilgear "ANY-SPEED" Drives on food filling and closing machines, food gear and metering pumps, fish cutting and filling machines, harvesting machines, conveyors, paper and packaging machines, sawmill carriages, machine tools, extruders, cable wrapping machines, missile launchers, printing presses, capstans, winders, hoists, winches, welding machines, and a variety of processing machines in the textile, food, chemical, paper and other industries where precision speed, direction and position control are advantageous.

For similar practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

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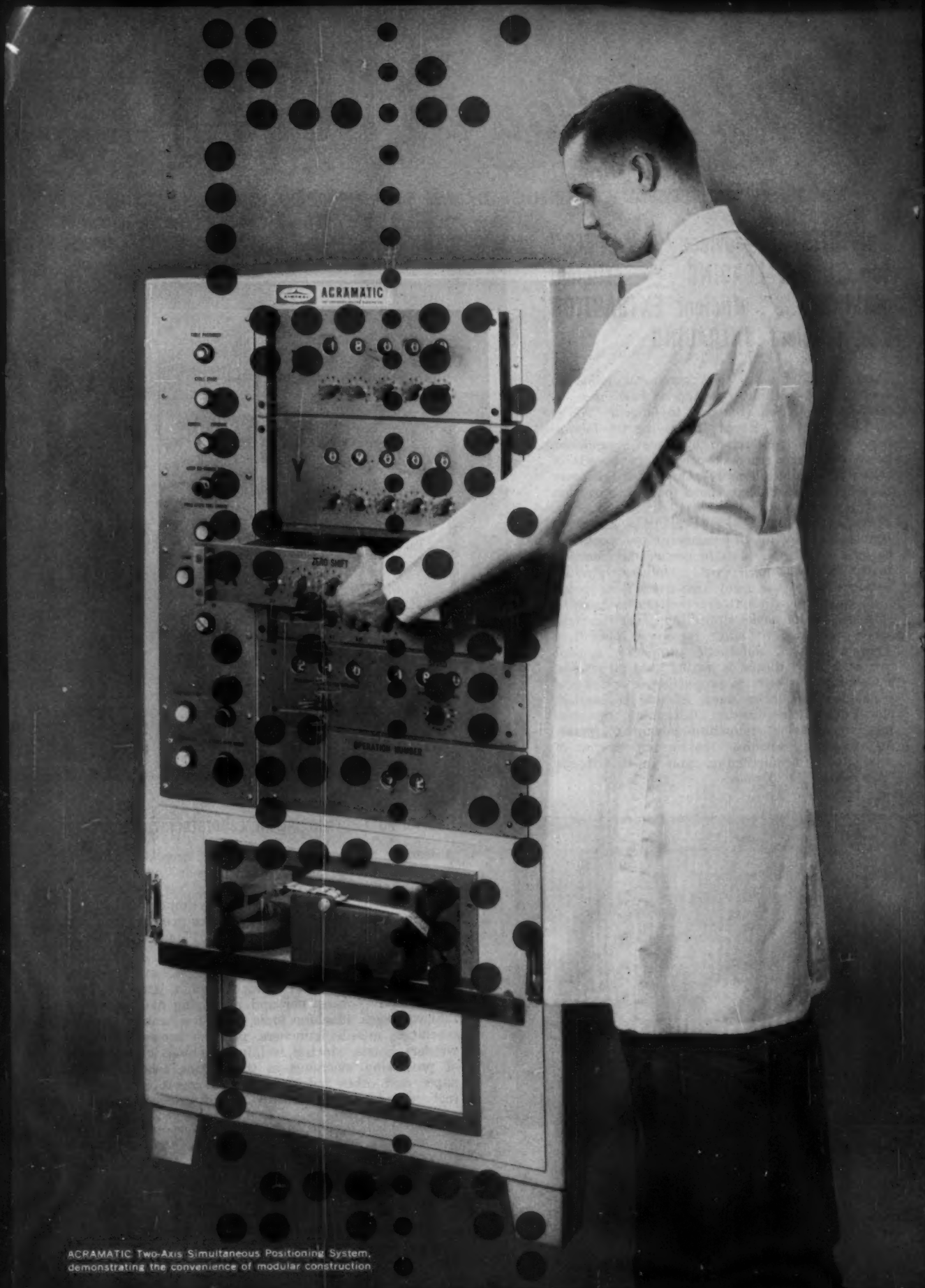
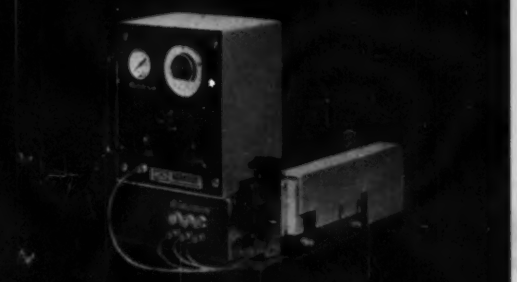


ACRAMATIC Two-Axis Simultaneous Positioning System, demonstrating the convenience of modular construction



ACRASIZE "Jump-on" Gage System

GRIND-A-MATE Gage System

ACRATRACE three dimensional tracer mechanism

ACRAMATIC Contouring System feedback unit

Electro-hydraulic Servo Valve

CINCINNATI

CINCINNATI MILLING ANNOUNCES CIMTROL DIVISION

More than 30 years ago The Cincinnati Milling Machine Co. pioneered in the use of hydraulics for milling machine control. This basic method of control led to the development of many unique types of hydraulic, electronic and electro-hydraulic controls and systems—for milling, grinding, die sinking, broaching and special machines built by Cincinnati.

So important is this technology today that Cincinnati has established the CIMTROL Division (compounded from the words "Cincinnati Milling" and "control"). The only full line manufacturer of machine control systems, this new Division is responsible for engineering, manufacturing, marketing and servicing of controls for applications in products of original equipment builders.

The CIMTROL Division's exhibit at the Machine Tool Exposition presented three groups of products: ACRAMATIC Numerical Control; ACRATRACE tracing systems; ACRASIZE gaging systems. The Division also offers programming services for ACRAMATIC Numerical Control. Original equipment builders are invited to present their machine control problems to Cincinnati. CIMTROL Division engineers have the background to work out the best solution. **Cimtrol Division, The Cincinnati Milling Machine Co., Cincinnati 9, Ohio.**

CIMTROL CINCINNATI

ACRAMATIC NUMERICAL CONTROL SYSTEMS • ACRATRACE TRACING SYSTEMS • ACRASIZE GAGING SYSTEMS

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NEWS OF BULK HANDLING

...pneumatically

Halliburton Pneumatic Systems transfer bulk materials anywhere pipe can be run

For the past 35 years Halliburton has transferred over 500,000,000 cubic feet of materials in its worldwide service to the oil and gas industry. This pioneering of bulk handling systems and the later development of *pneumatic* systems was made possible by Halliburton's Technical Research Center, where such systems are designed. Halliburton also has *two* modern manufacturing plants which are fully equipped to produce these systems in accordance with the strictest design requirements. The resulting Halliburton Pneumatic Bulk Material Handling Systems have proven much more economical and dependable than mechanical equipment. 50 million barrels of dry bulk materials have been pneumatically handled by Halliburton during the past decade.

STATIONARY SYSTEMS

Halliburton will custom design a complete stationary pneumatic handling system to the most exacting specifications. The Halliburton engineers who have designed and built scores of these plants are also available to supervise your installation. Halliburton can do the actual construction, or if desired, provide the equipment for installation by the customer.

Standard units are designed to convey materials up to 40 cu. ft. per minute at distances of 1400 feet with 100 foot rise. Special units can be designed to move materials further . . . and faster.

MOBILE SYSTEMS

Halliburton Mobile Pneumatic Systems are available for over-the-road, rail, or marine transport.

SPECIAL PRODUCTS DIVISION

for more information
about faster, cleaner,
more economical handling
of dry bulk materials
write direct to
Special Products Division.....

Halliburton
COMPANY • DUNCAN, OKLAHOMA

Circle 659 on Page 19

AUTOMATION news

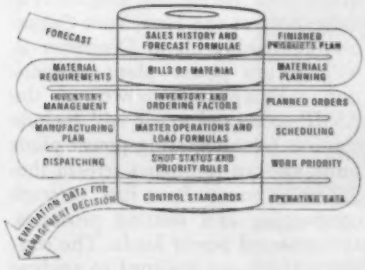
Today's events and developments in the field of automation

Data Processing System Integrates Company Functions

CONTROL of manufacturing functions, from raw materials to finished products, is integrated through the medium of data processing with a system developed by the Data Processing Div., International Business Machines Corp.

Requiring only existing data processing equipment, the Management Operating System, designated MOS, can be fully activated by a customer order in punched card form. When a card is entered, six interrelated functions which are basic throughout manufacturing industries are carried out. These are sales forecasting, materials planning, inventory management, plant scheduling, work dispatching, and operations evaluation.

Basis for MOS is the interaction between primary manufacturing control functions which generate plant activity (see diagram). Thus, sales forecasting produces a finished product plan as required machine output. This, in turn, is entered as input for materials planning. When passed against bills of material stored within the system, the finished product plan produces total materials requirements. Materials requirements are checked against inventory, also stored within the system, to initiate purchases and manufacturing orders.



CIRCULAR FORMS represent magnetic discs containing information stored in data processing system. MOS concept points way to logical processing of input data against information on discs so as to provide useful management reports for control of manufacturing operations.

APPLIED to inventory control and materials management phases of production, an IBM RAMAC 305 computer, background, is used at American Bosch to check inventory status of all materials, components, and subassemblies involved in producing desired quantities of up to 1000 end products. Necessary purchase requisitions and shop fabrication orders are prepared automatically by the system.

This chain of events, which is set in motion each time a customer order is entered into the system, continues through scheduling, dispatching, and finally operations evaluation. The latter step monitors the preceding five functions and automatically creates exception reports for management. These reports bring to management attention any significant variations from established operational standards.

In a partial application at American Bosch Div., American Bosch Arma Corp., the system is credited with effecting savings of $120,000 annually through better materials and inventory management.

Using an IBM RAMAC 305 data processing system, American Bosch can complete processing of a production schedule order with a single punched card. Accepting the card, the computer scans a magnetic disc file containing 10 million characters of information and establishes the time relationships needed to produce each component of the finished product. Within three minutes, the computer can determine the effect of the order on any of 15,000 parts which go into 1000 end products. Depending upon inventory status, the computer allocates components from stock or schedules them for production in economical quantities.

Institute Acquires Punched Tape Photocomposer

TEACHING the latest developments and techniques in lithography is the function of the Chicago Lithographic Institute. Operated by lithograph employers and a craft union, the school is based on the idea of labor-management co-operation in upgrading the essential skills vital to the industry.

An automatic photocomposing machine donated by Sun Chemical Corp. provides students with the

opportunity to master advanced printing techniques. The machine is manipulated by punched tape to turn out multiple negatives or plates to speed up the lithographic printing process and increase productivity. It duplicates images contained on transparent negatives or positives as many times as desired, registering accurately to within 0.001-inch.

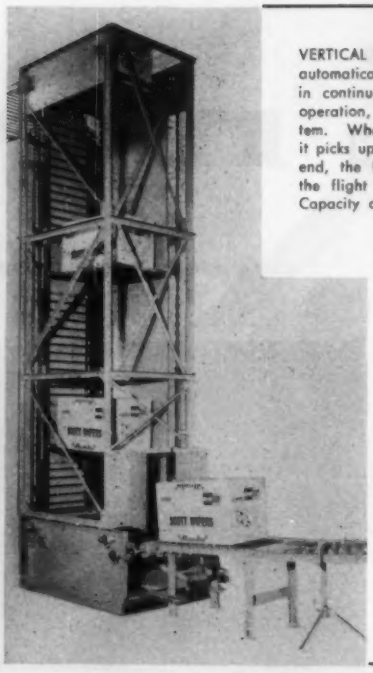
Company To Produce Automatic Equipment and Control Systems

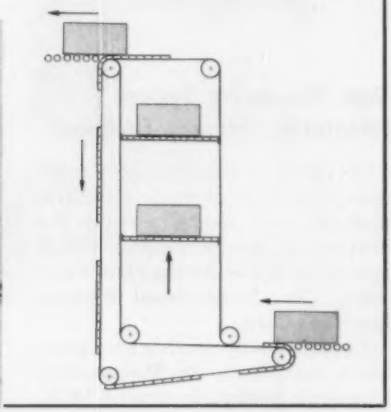
NEWLY formed company, Electronic Controls Inc., has named **Henry Morgan** its president and general manager. The company is engaged in design, manufacture, and marketing of automation equipment and control systems for military and industrial applications. The organization includes two divisions, one devoted to sales engineering and the other to product manufacture.

The sales office provides application information and service for switching devices, magnetic clutches, saturable reactors, transformers, phase sensitive detectors, servo system analyzers, testing machines for missile and aircraft components, and hydraulic systems for testing the hulls of ships and submarines.

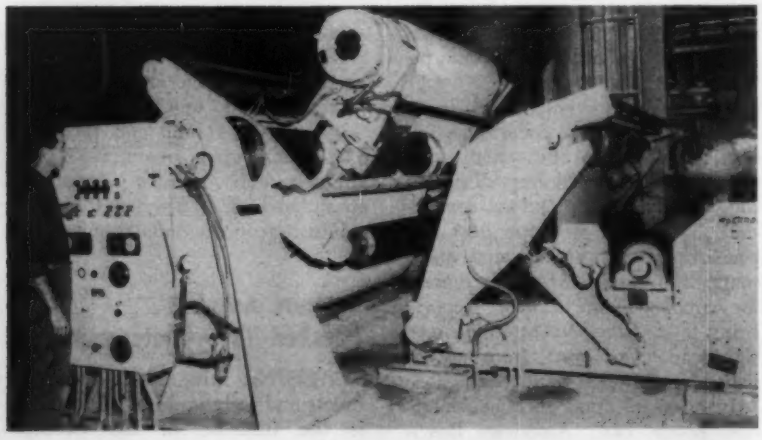
In the manufacturing division, it is delivering electronic motor drives for automatic speed control of machine tools and other electrical machinery. Also being manufactured are electronic controllers and power sources for spectrophotometers and spectrofluorimeters.

Morgan brings to Electronic Controls Inc. a background which includes experience as a management consultant and teacher of a college-level course in statistical quality control. He is a former executive with Burndy Corp.





VERTICAL CONVEYOR built by Standard Conveyor Co. automatically transfers loads from one level to another in continuous motion which may be up or down. In operation, flexible flights are circulated by a chain system. When a flight reaches the input end of the unit it picks up a load and moves it vertically. At the output end, the load is transferred to a service conveyor and the flight is recirculated to the input end of the unit. Capacity of the system is 8 to 10 loads per minute.



AUTOMATIC unwind-splicer, installed in a paper mill by Waldron-Hartig Div., Midland-Ross Corp., continuously feeds paper from rolls up to 152 inches wide to coating equipment. Rolls up to 5 feet in diameter, weighing up to 7 tons, may be fed at speeds up to 1000 fpm. In operation, as an old roll (at top) runs out, the operator pushes a button which moves an air-operated splicer arm into position. A second button starts action to rotate the unwind so that the old roll is moved out of running position and replaced by the new roll. A third button causes a friction wheel on the splicer to rotate against the new roll, bringing it up to web speed. A fourth button activates a photoelectric device which detects a black spot on the new roll. This moves a splice roll to bring the old roll into contact with the adhesive-coated leading edge of the new roll. As the new roll begins to unwind, the spot is detected a second time. A knife then cuts off the old web and a brake brings the old roll to a stop.

Power Plant Automation Feature Of Exposition

NATIONAL EXPOSITION of Power and Mechanical Engineering to be held at the New York Coliseum, November 28 to December 2, will feature power plant automation. Equipment shown at the ASME-sponsored event will include controls for integrating power plant units into an unbroken stream line to convey energy from fuel, through combustion and heating processes, to connected power loads. The control systems are designed to analyze individual operations and regulate the process to secure maximum economy in the over-all operation of a power plant.

Instruments for combustion control, flue gas analysis, boiler water

WHAT GOES ON HERE?

Bell Telephone Laboratories' new electronic "nerve cell" is a step toward finding out

One fascinating area of communications has long resisted exploration—what happens inside the nervous system when you see, or when you hear.

This area is of special interest to telephone science; knowledge of how the nervous system handles sound and picture signals can help determine what information is essential to perception. This in turn may lead to more efficient communication instruments and systems.

To probe the mystery of nerve activity, Bell Telephone Laboratories scientists have developed an electronic model of a living nerve cell or neuron. Consisting of transistors, resistors, capacitors and diodes, the "artificial neuron" exhibits many of the characteristics of a living neuron; for instance, "all-or-none" response and fatigue.

In one experiment at Bell Laboratories, a network of artificial neurons is subjected to a stimulus from light through a set of photocells. The network can distinguish specific patterns of light and dark, thus duplicating roughly some of the eye's basic reactions to light. Similar studies are underway to explore our hearing processes.

At present, too little is known about neural action to permit exact electronic duplication. But experiments with artificial neurons can provide suggestive clues, contributing to a stimulating interplay between electronics and neurophysiology which may help workers in both disciplines.

The human nervous system, including the brain, is the most efficient and versatile data processing system known; and data processing is an essential part of communications. The artificial neuron provides a new approach to investigating and understanding basic nerve network functions. It is a fresh example of how Bell Telephone Laboratories constantly explores new frontiers to improve America's communications system, now and in the years ahead.

Network of neurons is assembled by L. D. Harmon of Bell Laboratories, the initiator of this new research. Many kinds of assemblies are possible.

A single artificial neuron. It delivers electrical impulses when stimulated, like a living cell. Neurons are also being used for research into hearing.

BELL TELEPHONE LABORATORIES

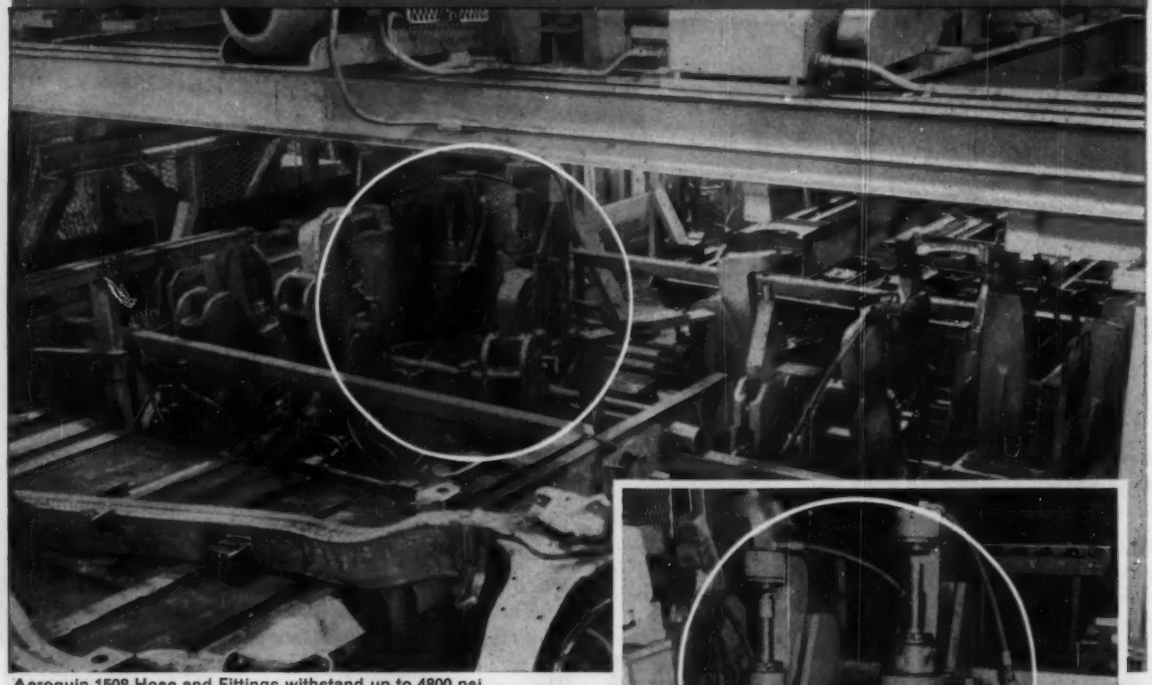
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

For 4800 psi PRESSURE SURGES

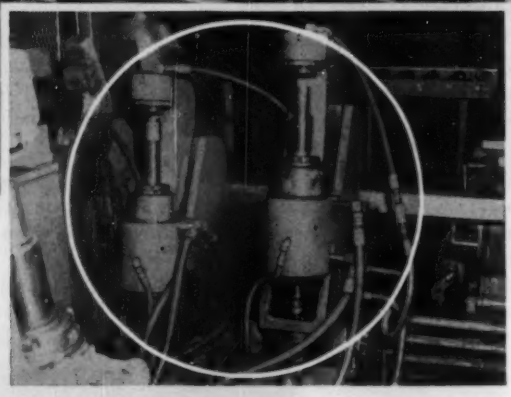
Tool Engineer Specifies

Aeroquip *Hose Lines and Reusable Fittings*

From job report by large automotive plant producing auto frames and stampings



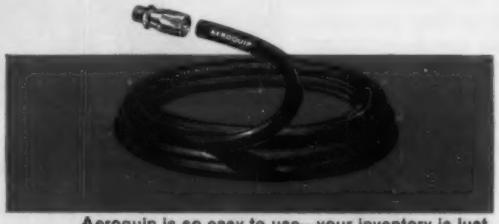
Aeroquip 1508 Hose and Fittings withstand up to 4800 psi on this body bolt piercing machine.



The experience of this tool engineer has proved that a bulk stock of Aeroquip Hose and Reusable Fittings can expedite the design and maintenance of automated production machinery such as automatic body bolt piercing machines. In this application Aeroquip Very High Pressure Hose, under constant flexing and pressure surges up to 4800 psi, helps avoid down-time and keeps production running smoothly.

When infrequent Aeroquip Hose replacements are required they can be made on the job, quickly, easily and with minimum down-time. Hose can be cut as needed, no special tools are required. Fittings can be reused. Result—fewer and briefer interruptions to work flow.

Your Aeroquip Distributor is a fluid line specialist. He will give you a copy of our industrial Catalog No. 204 and explain why you are in good hands when you consult with Aeroquip. Call him. His telephone number is in the "Yellow Pages" under "Hose."



Aeroquip is so easy to use—your inventory is just a few feet of hose and a handful of fittings.

STANDARDIZE ON Aeroquip

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Circle 660 on Page 19

analysis, pH indication and control, and feed water analysis will also be exhibited. The Exposition is being held in conjunction with the Winter Annual ASME Meeting in New York.

New Industrial Leasing Company Formed

IN ORDER to give more consideration to the individual situations of industrial and business clients, M. & E. Leasing Corp. has been formed as an affiliate of C. I. T. Corp., with **Thomas E. Lenihan**, president of C. I. T. Corp., heading the new leasing company. According to **Richard S. Murphy**, vice president of C. I. T. Corp., the new company is prepared to purchase machine tools and other manufacturing equipment for leasing purposes, leaving C. I. T. Corp. in a position to work out, with the clients, the best methods for acquiring the use of machine tools and other production equipment. "Consideration can be given to whether a purchase or lease arrangement is better suited to the individual situation," Mr. Murphy stated.

Magnetic Ink Use Extended To Supermarkets

TEDIOUS job of handling billions of coupons that are redeemed in supermarkets each year has been alleviated with the development of magnetic ink sorting and processing equipment by Datamation Inc. With the new process, the coupons can be made of paper and the identifying symbols printed on them in

Scientific Computer Guides Process on Shared Time Basis

CLIMAXING a 2-year joint study, International Business Machines Corp. and Standard Oil Co. (Indiana) have demonstrated the feasibility of computer control of a large crude oil distillation unit. Located approximately 1 mile from the site of the distillation unit, an IBM 704 computer system has been augmented with several special pieces of equipment that enable coded signals to be received via a telephone line. The data are processed by the computer to obtain suggested control settings as well as a variety of engineering reports that describe conditions of the distillation units. Selected portions of the output of the computer are periodically transmitted back to a typewriter readout station (located in the instrument house adjoining the distillation unit) to guide an operator in making controller adjustments.

The demonstrated open-loop phase is part of a continuing joint study by the two companies in investigating the role of computers in obtaining efficient control of petroleum refinery operations. In this application, the computer makes process control calculations on an "interrupt" basis, sharing time with engineering studies being made on the computer.

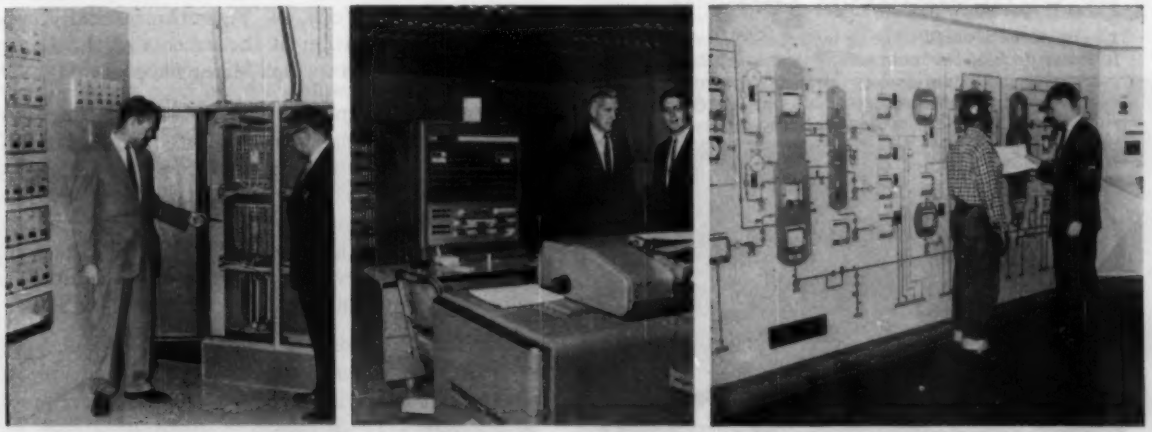
The control concept used includes two broad phases. The first seeks an accurate diagnosis of current operating conditions of the plant. The second involves the optimization which leads to recommended adjustments to controller set points.

The diagnosis is developed as the computer automatically scans readings from 196 different instruments. Data may also be added manually based upon laboratory inspections. The best estimate of current operating conditions is then obtained, considering primary and other variables.

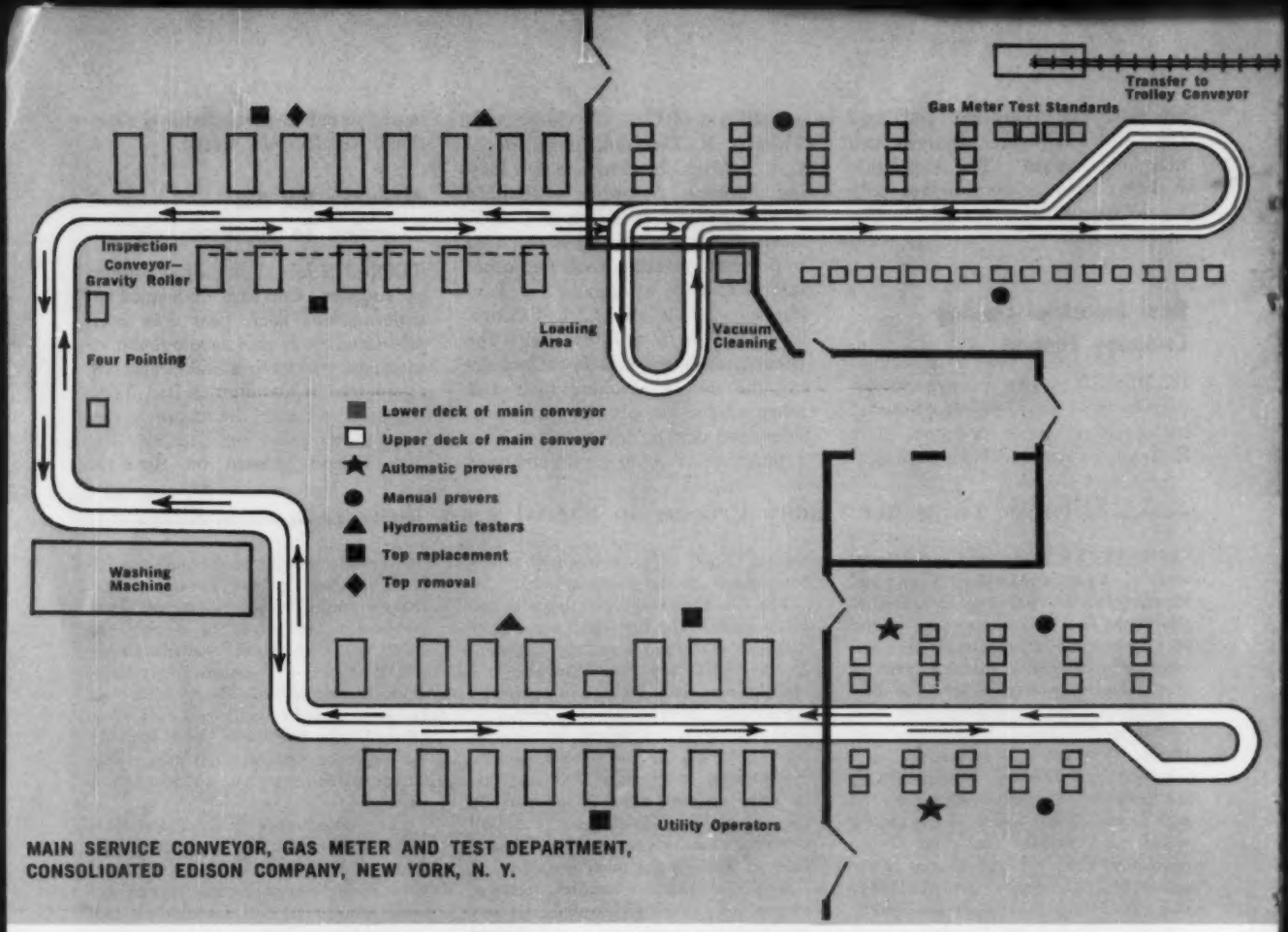
In the optimization function, values of constrained variables (equipment and production limitations, etc.) are compared with actual constraints. An approximate profit equation is also introduced, along with any other additional constraints imposed by management. Using linear programming techniques, 54 of 161 dependent variable equations are optimized to find the proper settings for up to 19 primary variables.

Optimization yields a detailed picture of the "room for improvement" existing in the current operating condition. Once this is established, it also determines the changes needed to take advantage of the projected improvement. To do this, the effects that each primary variable change will have on each constrained variable must be considered. These effects are known as response coefficients, and actual values of the coefficients have been developed from chemical engineering calculations carried out on an incremental basis.

The demonstration is significant for a number of reasons: So far as the oil industry is concerned, where good control of a basic refining process is now obtained, the promise is that excellent control can be realized. So far as the computer industry is concerned, a complex processing operation has been shown to be amenable to computer control. Sophisticated mathematics and computational techniques have been exploited, laying the groundwork for an expanding use of computers in control applications. So far as industry in general is concerned, the event served notice that IBM is indeed interested in the process control field.



JOINT EFFORT of IBM and Standard Oil Co. (Indiana) has resulted in open-loop computer control for crude-oil distillation unit. Pneumatic signals from process are brought out to terminal unit and converted to electrical analogs by transducers (left). Following a digitizing and coding operation, signals are transmitted to IBM 704 computer (center). Suggested optimization settings for controllers are transmitted back to distillation unit and typewritten report is prepared to guide operators (right).

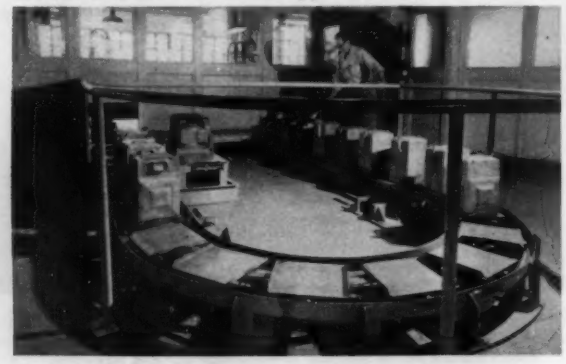


MAIN SERVICE CONVEYOR, GAS METER AND TEST DEPARTMENT, CONSOLIDATED EDISON COMPANY, NEW YORK, N. Y.

Logan *Plant Dynamation* System

pays for itself in 1 year at Consolidated Edison

Loading area, where incoming meters are placed on the 202-ft. lower deck of the main service conveyor. Both decks are carousel type, chain-on-edge driven conveyors. Specially designed individual carriages hold one larger-type meter, shown here, two of a smaller type also serviced.



When 1200 feet of chain, trolley, belt, and roller conveyors pays for itself in a single year, usually the reason is better engineering. Consolidated Edison Company, New York, N. Y., enthusiastically supports this explanation of the success of the Logan system installed in its Gas Meter Shop in mid-1959.

From the first planning stages, the Logan Plant Dynamation specialist collaborated with Consolidated Edison on the ingeniously simple conveyor system and revised department layout shown here. The system mechanizes work flow on scheduled maintenance checks of about 4,000 gas meters per week. Meters previously were moved through the department by hand-truck.

Benefits and savings are reduced labor costs, space savings, continuous production, new versatility to meet shifting needs, minimized damage to meters, better safety conditions and reduced fatigue for workers. The conveyors have required no maintenance other than periodic lubrication and servicing.

Here the double-decked portion of the main service conveyor carries meters through an incoming test section. A tag applied here designates service steps to be performed as each meter carousels through the shop. Any incoming test bench and worker can be switched to final testing or meter adjusting, when relative work loads so dictate.

One end of the two elongated merry-go-rounds, seen from the trolley conveyor transfer point. Since the conveyor is a moving work bank for the individual benches, a meter may pass this point more than once before being transferred from the lower deck to the upper deck or out of this system to the trolley conveyor.

Dispersal and de-specialization of work proved to be surprise keys to the dynamics of numerous bench-work steps performed on the meters. Incoming meters are removed from the lower section of the double-deck main service conveyor, tested, then placed on the 720-ft. upper deck. This conveyor loops continuously among all the work bench areas. However, each step is performed at two or more separate points. Thus, meters are removed and replaced a few at a time, eliminating lengthy waits. Frequently-varying needs are met by certain benches and workers prepared to perform any of three steps on demand.

A tag system designates steps required on each meter. The meters are continually moved back and forth between the benches and main conveyor, but all handling is at one convenient level once meters have been placed on the upper deck.

After internal servicing, a 240-ft. continuous trolley conveyor takes the meters down two floors, through a degreasing installation and a paint booth. They are re-sealed on a final section of Logan belt conveyor, which carries them to shipping.

Logan conveyor design helps harness all the work power potential of your plant

A number of different conveyor systems might pace your process "efficiently." However, between the *least* efficient and the *most* efficient of these, many thousands of dollars can be gained annually in bigger output and lower costs.

The Logan technique of Plant Dynamation eliminates hit-or-miss from conveyorizing. The Logan engineer helps you analyze your operation's *basic work-power patterns* . . . then moves step by step to design the *one right* system dictated by these patterns.

Over the half-century in which assembly-line production itself has grown up, Logan engineers have developed and proved their exclusive Plant Dynamation technique through thousands of custom installations. On an average, "The Man From Logan" stationed in your area has participated in fourteen years of this vital experience.

One of the most comprehensive lines of conveyor equipment permits the Logan engineer to specify freely. Both as supplier and designer he commands five distinct modes of power and control: gravity, electricity, hydraulics, pneumatics, and electronics. Every "Man From Logan" has made original contributions to the concept of automation.

"The Man From Logan" stationed near you is quickly available. It pays to include him in the early sessions of new-plant or plant-revision planning. And he works directly with your engineers through installation to smooth operation. Write or phone today for a conference with this specialist in Plant Dynamation.

Logan Conveyors

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Circle 661 on Page 19

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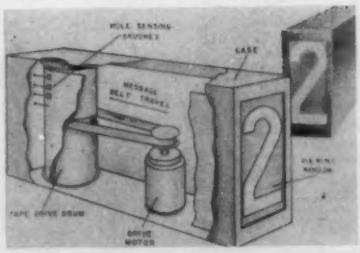


DIGITAL INDICATOR, designed by Electric Indicator Co. Inc., operates on a belt-positioning principle to eliminate positioning errors. This principle utilizes the position of holes in a movable message belt in the indicator to decode input signals. The signals may be from single-wire input, 4-wire binary coded, or 10-wire input signal systems, operated semiautomatically or manually. Message belt slippage and position adjustment problems are minimized because of this design. Receipt of an input signal initiates operation of a permanent magnet induction drive motor. The motor drives the message belt until a preselected series of holes in the belt is properly positioned under a series of hole-sensing brushes. No brakes, clutches, or positive adjustment devices are required.

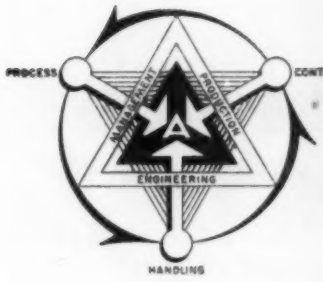
magnetic ink. The symbols, when passed through the processing machine, transmit a signal which is retained and automatically evaluated by the equipment.

Now all the coupons can be sent, in bulk, to one processing center. This equipment, already being used by banks to process checks, will save time and reduce processing costs by more than one half, according to **John Munzo**, research director of Datamation.

RWMA Members Hear Talks on Spike Welding And Automation

AT THEIR third regular business meeting in 1960, members of the Resistance Welding Manufacturers' Association heard two feature talks by guest speakers. Hosts for the event were Kirkhof Mfg. Corp. and Goodrich Welding Equipment Corp. RWMA members, representing eight major manufacturers of welding equipment, were present at the meeting.

Stuart Rockafellow, vice president and director of engineering, Robotron Corp., spoke on spike welding. A recognized authority in the field, Rockafellow covered the scope of spike welding applications and brought his listeners up-to-date on



around the triangle

DETECTS FLAWS IN TEXTILE YARNS

An electronic device for use in textile mills automatically detects, counts, and indicates imperfections in yarns and fibers during processing. The yarn inspector, which was developed by Lindly & Co., Inc. is capable of simultaneously checking several thousand strands of multifilament synthetic yarns for textile and tire cord as they move through the warping process. Heart of the unit is a sensitive photoelectric system that scans the strands of yarn as they speed across an inspection bar. Defects measuring less than a thousandth of an inch can be detected. The sensitivity of the system can also be adjusted to detect only certain types of flaws while permitting others to pass unnoticed.

NO SIGNAL AMPLIFICATION FOR THIS RECORDER

Miniaturized temperature recorder features a meter movement that is sensitive enough to permit temperature recording without a signal amplifier. The recorder operates directly from a thermocouple, with a meter movement calibrated to match the thermocouple. The recorder, designed by Assembly Products Inc., operates on a clamper bar principle. Every four seconds, the pointer on the moving coil is clamped briefly. A marker on the pointer then prints the pressure-sensitive chart paper, without use of ink. Recorder has a minimum temperature span of 0 to 500 F, and a maximum span of 0 to 2500 F. Accuracy is ±2 per cent of full scale.

ADHESIVE FOR ELECTRICAL USES

A synthetic resin-type adhesive which can be air or oven-cured has been developed by B. B. Chemical Co., an affiliate of United Shoe Machinery Corp. It can be effectively used on components where phenolic-impregnated fabric or electrical board must be adhered to metal. By adding silver, copper, or bronze powder, or an acetylene-type carbon black in coarse particle size, the adhesive can be used as a conductive coating medium. The adhesive will bond at ordinary room temperature, but a thermosetting reaction, occurring at 250 F or above, provides maximum film strength. At 300 to 350 F, curing is accomplished within 18 minutes.

MACHINE TOOL DAMAGE PREVENTED BY SENSING DEVICE

Damage to automatic machine tools because of oversize workpieces can be prevented with an electrical sensing device developed by Michigan Tool Co. The attachment has been successfully applied to a gear shaving machine as a cutter protector. In use, one of two pointers on a meter-relay is set to the maximum load allowed. The second pointer on the device indicates the actual cutter load. If the load equals or is greater than the preset limit, the device automatically interrupts the machining cycle. The sensing mechanism operates by continuously checking the armature current being drawn by the cutter-drive motor, and can detect stock variations in thousandths of an inch.

PROTECTIVE COATING FOR WIRE CLOTH

Teflon coated wire cloth woven from stainless steel has been developed by Cambridge Wire Cloth Co. The Teflon coating is applied evenly over the entire surface of the industrial wire cloth and will not interfere with mesh openings in mesh sizes as fine as 180 per inch. Applications for this material are seen in filtration operations where water is present, since the Teflon coating has a tendency to hold the water back and allow other liquids to pass through.

AUTOMATION

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428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
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recent developments in methods and equipment.

James C. Keebler, managing editor of AUTOMATION, discussed the growth of automation and its present and future impact on the U. S. economy. Of particular interest to his listeners were his remarks on the relation of automation to labor, to U. S. manufacturers' potentials in the export market, and, specifically, to the welding industry.

LINE of automatic inspection systems has been introduced by Norden Div., United Aircraft Corp. Input can be either manual, manual numeric, or from punch tape. The output is in the form of a decimal display, printout, or an eight-channel punch tape record. Systems are absolute rather than incremental and provide either actual dimensions, deviations from nominal values, or out-of-tolerance indications.

Thickness Gage Operates Magnetically

THICKNESS of coatings on piston rings, thin wire, screws, nuts, pipes, and cylindrical containers is tested by a gage developed by Twin City Testing Corp. The instrument can gage the thickness of coatings on iron and steel, as well as the thickness of foil or sheets made of nonferrous materials.

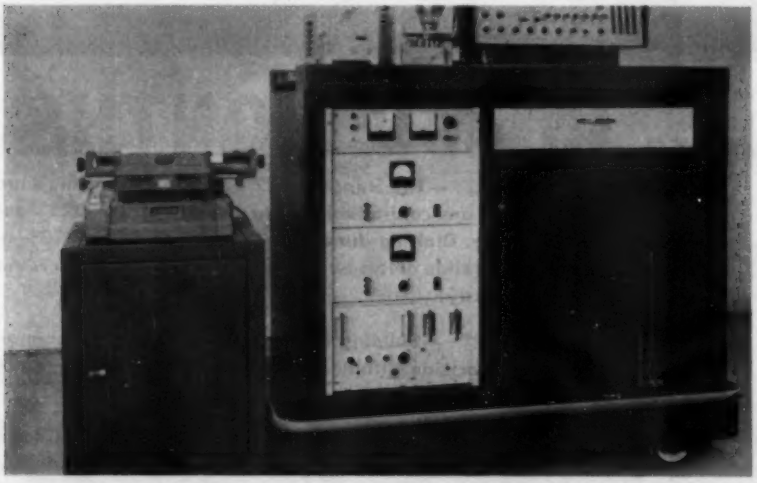
A small, 2-pole probe works on the principle of a magnetic amplifier. To measure the thickness of a coating, the probe is applied to the surface. A closed magnetic field is created between the poles of the probe with the lines of force largely contained within the base metal. The thickness is indicated on one of the direct-reading scales of the instrument.

Four probes are available with various distances between poles. An attachment can be furnished for applying a probe at constant pressure to soft materials and small-diameter wires.

Bearing Lubricant Developed For Use In Extreme Conditions

SELF - WICKING lubricant for bearings operating in extreme environments has been announced by Permawick Co. and its licensee, Wesco Mfg. Co. The lubricant is recommended for applications involving high or low temperatures, marginal and boundary lubrication, and high thrust loadings.

Key to the new lubricant is an extreme - pressure additive, formulated specifically for bearing use. The new oil formulation has a pour



DATA LOGGER system that automatically balances up to 1000 bridges and logs their millivolt output signals in a programmed mode has been developed by Consolidated Systems Corp. The system samples 210 channels of analog data per minute sequentially, commutates and converts the analog data, and punches tabulated data in a paper tape at a rate of 60 five-digit characters per second. The punched tape can be used as an input to an off-line printer. Information punched on the tape includes channel number, digitized value, overscale data, and samples per line and carriage return data for the off-line printer. System is recommended for use where 100 or more bridges are used in static testing.

Feedall

hopper-loading, parts orienting... completely self-contained

automatic feeders

feed rolling or sliding parts faster, easier, at lower cost

Feedall machines are a perfect complement to your high-speed operations. They eliminate hand feed, assure uniform output and maintain a pre-set parts flow-rate. Moreover, they perform with multi-million cycle reliability, precisely controlled to fit your production needs in cost-saving operation.

Easily Installed. A Feedall forms an integrated, high-speed automatic unit when combined with a centerless grinder, milling machine, forging press, or similar machine. Placed next to the machine to be fed, the Feedall is ready to operate, proved in hundreds of installations. Write for details today.

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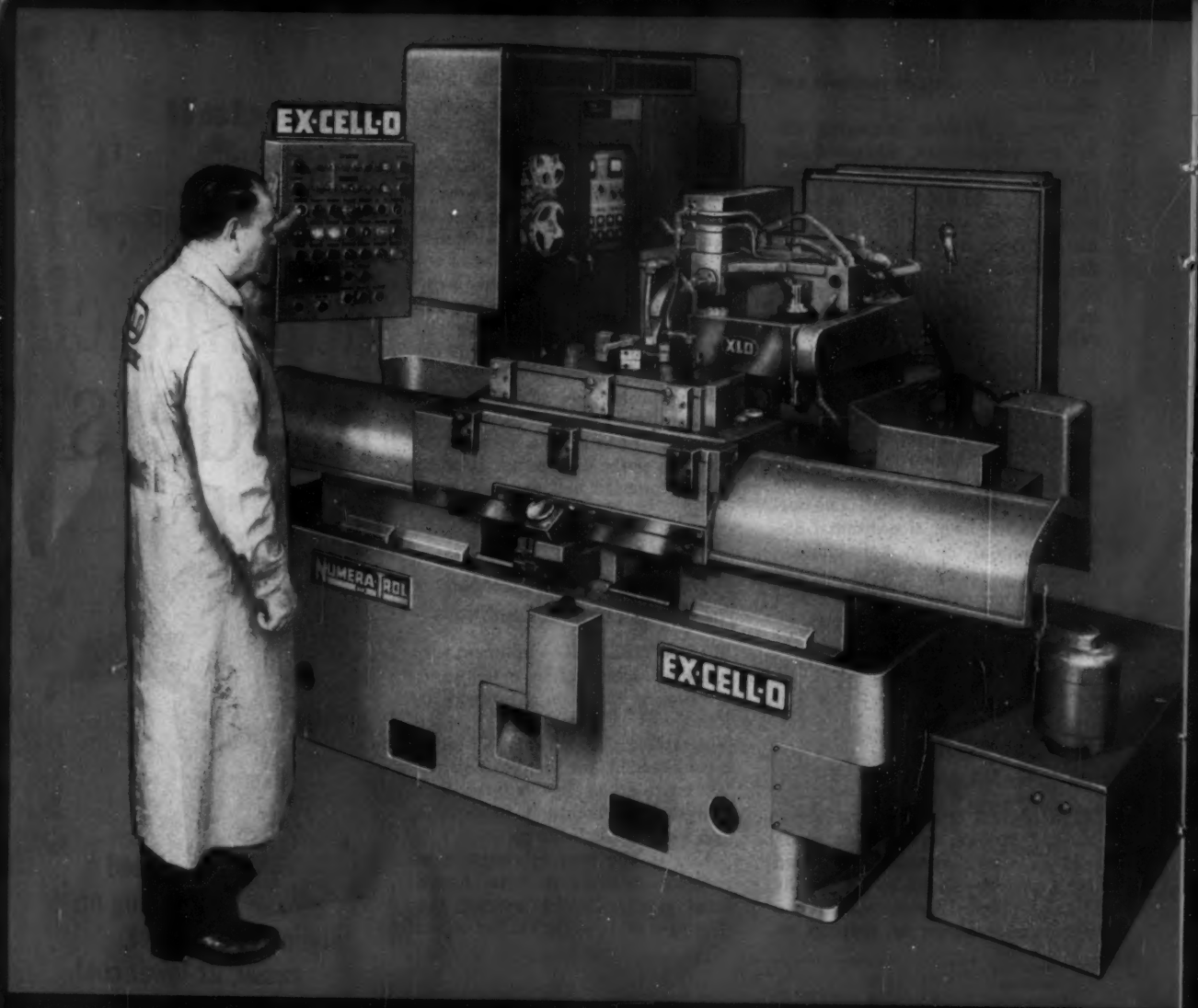


TOLERANCES IN MILLIONTHS . .

Plus versatility— Interchangeable Units for tape-controlled Grinding, Turning and Boring

SPACE-AGE ACCURACY —The Standard 922 Contouring Machine's main slide and cross slide are controllable in increments of .000025" automatically or manually. Dial the dimension, from .000025" to .10", and the main slide or cross slide of this two-axis machine advances or retracts by that amount—exactly!

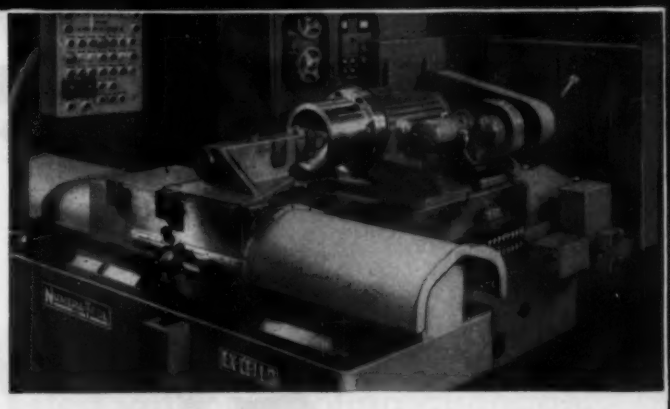
ECONOMY, VERSATILITY —Building-block construction permits changing in minutes from a precision grinding assembly to a precision turning-boring unit. Unitized design adds versatility, cuts downtime.

FULLY TAPE-CONTROLLED —Used with high-performance pulse data input, the Standard 922 provides fully automatic turning, boring and grinding, plus wheel dressing and dressing compensation.

TOMORROW'S MACHINES, TODAY —The Standard 922 is the latest in a line of Numera-Trol Machines performance-proved in customers' plants. Others include Precision Milling and Grinding Machines for machining turbine blades, small cams and other prototypes and production parts.

Standard Numera-Trol 922 equipped with grinding unit for precision templet grinding. Grinding assembly is easily interchangeable with boring and turning unit for accurate contouring operations.

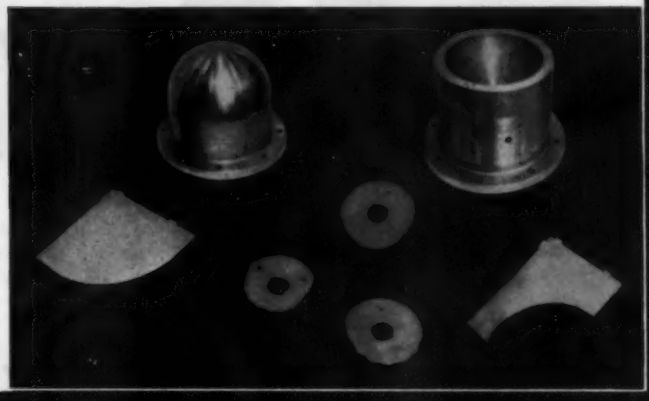
Machine is equipped for contouring by mounting boring and turning unit on main slide and tool holder on cross slide. Spindle speeds are automatically varied to maintain constant cutting speeds.



By setting dial and pressing button either slide can be moved in increments ranging from .000025" to .10" with total movement of 18" on main slide and 26" on cross slide.

Operation is monitored by electronic "Nixie" counting tubes and by direct-reading optical vernier. This mechanical and electronic read-out combination gives "closed loop" accuracy control during all operations.

Numera-Trol Contouring Machine simplifies production of parts with complex contours, ends need for blueprints and models, permits fabrication of prototypes and production parts directly from designer's mathematical directions.



with the world's most accurate production machine tool!

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59-71

FREE—
NUMERICAL
CONTROL
GUIDEBOOK

"A Guidebook to Numerically Controlled Machine Tools," a valuable addition to your technical reference library, is available without cost from your local representative, or by writing direct to Ex-Cell-O.

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EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • THREAD AND GROOVE GAGES • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

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IF YOUR COMPANY is one of those whose net profits are disappointing in spite of healthy sales volume—it's probably because your costs are rising faster than productivity per worker, per machine or per square foot of floor space . . .

NOW is the time to let us help you reduce overhead, and put new life in your present plant with A-F *Engineered* plant-wide *movement of parts, assemblies, products, cartons.*

Because A-F founded the unit conveying industry in 1901 and pioneered automated systems, you can be sure that an A-F Conveying System installation will produce real operational savings in 5 different ways.

May we explain these savings? Write—without obligation today.

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A-F *ENGINEERED* CONVEYING SYSTEMS

Also Pre-Engineered Conveyors—
Wheel, Trolley, Roller, Belt
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CYLINDER FORCE calculation chart, distributed by Sheffer Corp., is designed to determine what size hydraulic or pneumatic cylinders are required to perform given push or pull work functions. The force, cylinder bore, or pressure required may be found from a nomograph when any two of these factors are known. A chart of effective areas for double acting cylinders shows bore and rod areas for standard units. Chart is made of a dull finished varnished board and the straightedge is permanently affixed to it.

point of −40 F and is said to show virtually no loss of lubricity and only relatively minor viscosity changes up to 200 F.

MAGNETIC TAPE transport systems formerly produced by the D. G. C. Hare Co. will be designed, manufactured, and marketed by a newly formed Electronic Systems Div. of the Sangamo Electric Co. The new division has responsibility for all complete electronic systems including Sonar.

Company Formed To Develop Electrohydraulic Controllers

Continental Controls Co. is the name of a new organization that will specialize in electrohydraulic control components and systems. Headed by **Werner G. Holzbock**, president, the firm will manufacture a line of servo valves. Consulting service will also be offered, and, when required, specialized hardware will be designed, developed, and built.

Holzbock is a former manager of the Instrumentation & Control Systems Dept. of Sanders Associates Inc. He has also been chief engineer of GPE Controls Corp, A prolific technical writer, Holzbock is the author of numerous articles that have appeared in technical magazines here and abroad. He has also written two widely

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DENISON HydrOILics

16 different **VICTOR ADDING MACHINE** cases perforated without tooling changes, demonstrates **DENISON** Multipress...

VERSATILITY

PERFORATING *16 different plastic case designs without tooling changes, this 8-ton Denison Multipress reduces inventory requirements and speeds production for Victor Adding Machine Company, Chicago. Typical case after punching, shown at left.*

SHARPLY REDUCED inventory requirements, no scrap loss and production line versatility are just 3 of the important advantages gained with this Denison hydraulic Multipress at Victor Adding Machine Company.

Previously, stocks of at least 6 different basic plastic shells had to be maintained to produce cases for 16 different models in the Victor Champion line.

Now, with an 8-ton Multipress equipped with special tooling and controls which enable the operator to select a variety of punching combinations automatically, only *two* basic shells are required in stock. And *all* of the 16 different case design variations are perforated on the Multipress *with no change of tooling*. And the right shell is always on the assembly line at the right time.

Smooth, controlled hydraulic power perforates the "Cycolac" plastic, without charring or discoloring. Holes are clean and smooth ... there's no scrap loss ... punch life is significantly longer. This operation at Victor Adding Machine is another case-in-point showing how Multipress versatility and usefulness can save time and money in *your* plant. Call in the nearby Denison Production Specialist to discuss how a **M**ultipress **A**nalysis **P**rogram can start to **MAP** production savings for you now.

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American Brake Shoe Company
1234 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

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HYDRAULIC MULTIPRESS

Circle 666 on Page 19

A PRIME TOOL

for the Design Engineer

The North RVF Switch is more than a component—it becomes a tool in the hands of the imaginative design engineer, giving him maximum flexibility in circuit approach coupled with reliable service, long life, positive action and a minimum of simple maintenance.

Any combination up to 30 inputs and/or outputs per bank level and up to 6 levels with single wiper or 15 points per level and 12 levels with double wiper for application in control circuits and systems involving selection, sequential operation, scanning or totalizing.

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NORTH ELECTRIC COMPANY

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known textbooks: *Instruments for Measurement and Control*, and *Automatic Control: Principles and Practice*, both published by Reinhold Publishing Corp., N. Y.

Numerical Controls Available As Subsystems

POINT - TO - POINT positioning control system, designed by Square D Co., provides an absolute accuracy to ±0.001-inch and repeat accuracy to ±0.0005-inch. The system can operate a variety of precision machine tools such as drill presses and boring mills which require accurate positioning, and is suitable for multiple-axis control. Punched tape is used for predetermining sequences.

Feature of the system, designated RAPAC, is a nonwearing linear transducer which indicates the direction of travel toward the desired positioning point at all times. The control is available as a complete system or in the form of components for drive subsystems, data decoding subsystems, and measuring subsystems.

Oil Packaging Plant Converts To Aluminum Cans

ALUMINUM CANS have replaced steel cans at the East Boston packaging plant of Mobil Oil Co., showing results in the form of savings in shipping costs. Other advantages cited for aluminum cans are that they are rustproof, require less lithography, and are said to have greater sales impact because of their attractive appearance.

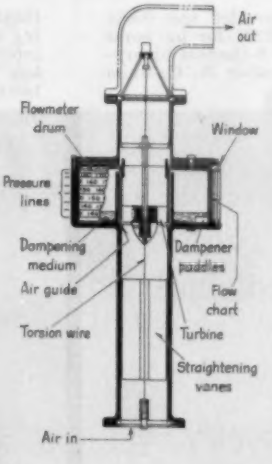
The complete shift from steel to aluminum cans was made without equipment change in a total downtime period of 48 hours. Among the line equipment items adapted for the new containers were a pneumatic packer, an automatic case gluer, and a case compression unit manufactured by Crompton & Knowles Packaging Corp.

Packaging rate for the aluminum quart cans is 405 per minute, the same as for the steel cans previously used. However, steps are being taken to increase this rate to 575-600 cans per minute in the near future.

New Officers Elected For Fluid Controls Institute Inc.

RECENT meeting of the Fluid Controls Institute Inc. was held at White Sulphur Springs, West Va., and new officers were elected to serve during the coming year. Included are **F. E. Weldon**, General Controls Co., as president of the Institute; **R. F. McCormick**, Automatic Switch Co., as 1st vice president; **E. A. Bianchi**, Mason-Neilan Div., Worthington Corp., as 2nd vice president; **P. K. Rogers Jr.**, Skinner Electric Valve Div., Skinner Chuck Co., as treasurer; **S. J. Reid**, Barnes & Jones

AIR-FLOW meter developed by Highland Engineering Co. provides direct deadbeat readings at any point on the circumference of its dial. With the unit, air flows from 20 to 200 cfm can be measured accurately at pressures from 2 to 12.5 psig. In operation, the dial of the instrument is actuated by a turbine wheel attached to a torsion wire stretched within a vertical duct. Air entering the duct from the bottom passes through a series of straightening vanes before acting on the turbine wheel. The air then rotates the turbine wheel against the opposing torque of the torsion wire, thus registering the rate of flow on the circular, calibrated dial. Deadbeat action is provided by dampener paddles that turn with the dial in a dampening medium. Pressure drop through the device is said to be only 0.1 psi, and accuracy of 1 per cent is claimed. According to the company, the design is applicable to the measurement of liquid as well as gas flows and can be adapted to operate at pressures up to 5000 psi. Applications for the device include leakage tests, pipeline flow measurements, and general purpose air flow metering.



SPHERCO®
BEARINGS

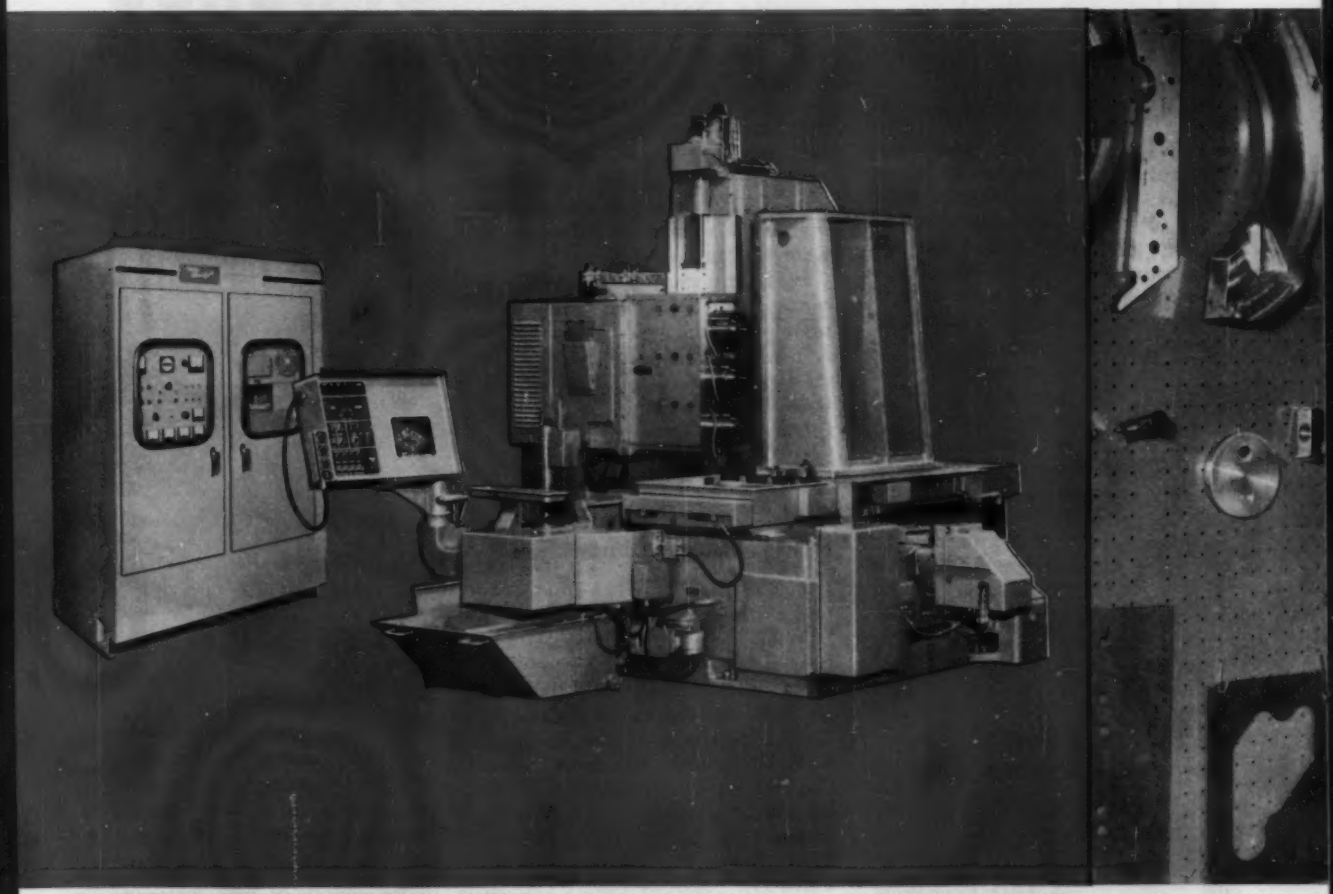
If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.

WRITE FOR BULLETIN 560

SPHERCO
A PRODUCT OF
SEALMASTER BEARING DIVISION
STEPHENS-ADAMSON MFG. CO
22 RIDGEWAY AVE. • AURORA, ILL.

Circle 668 on Page 19

NOW—BENDIX OFFERS COMPLETE LINE

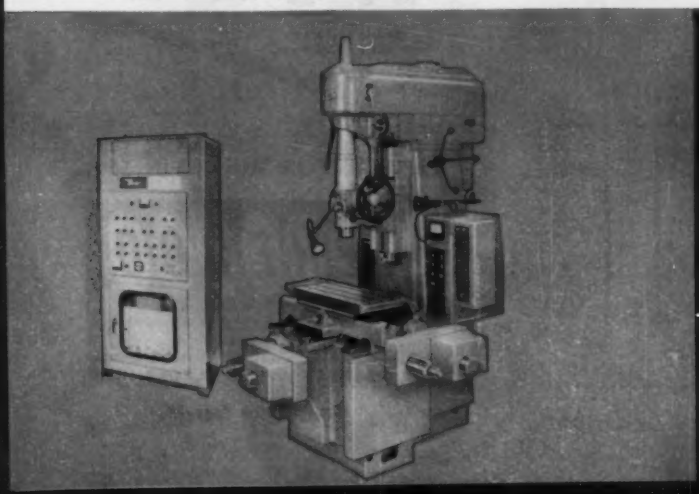


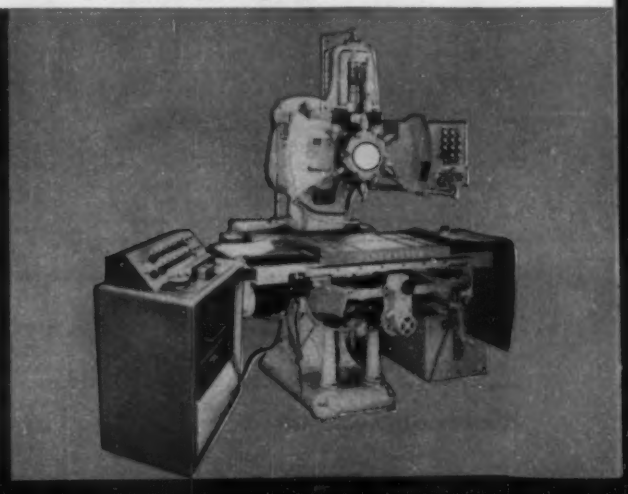
DYNAPATH-23 NUMERICAL CONTOURING CONTROL. Featuring *Circular Interpolation* to permit the close-tolerance machining of arcs and circles, as well as straight lines, with a minimum of input data. Offers 0.0002-inch resolution on 2, 3, or more axes of control. Each application individually engineered for the best possible combination of machine tool and control unit.

TREMENDOUS VARIETY of parts machined with Bendix numerical control shown here. Parts range from complex missile components to simple but extremely accurate cams.

DYNAPOINT-22 NUMERICAL POSITIONING CONTROL. Provides the finest electronic resolution available anywhere—0.000010″ for jig borer accuracies within 0.0001″ on finished parts. Uses 8-channel binary-coded decimal tape format—compatible with other N. C. units and with standard tape preparation equipment.

FERRANTI FP-22 NUMERICAL POSITIONING CONTROL SYSTEM. Floating zero for fast, easy set-up and low-cost tooling. Dial input provides manual operation flexibility. Wear and loss of accuracy eliminated because there are no contacting parts in measuring units.





OF NUMERICAL CONTROLS

New, completely transistorized POSITIONING and CONTOURING units provide greater reliability, lower operating costs and made-to-order accuracy.

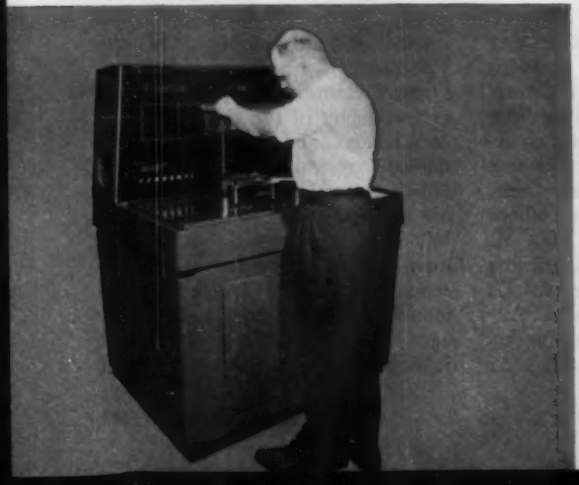
Tested and proven in scores of installations, over thousands of productive hours, Bendix numerically controlled contouring systems have become recognized as the finest. Based on this solid history of achievement, The Bendix Corporation now introduces its second generation control systems, the DynaPath-20 Series Numerical Contouring Controls, and the Dyna-Point-20 Series Numerical Positioning Controls.

To further extend its broad coverage of the numerical control field, Bendix has obtained exclusive rights to distribute the Ferranti tape controlled positioning units and Ferranti's unique coordinate measuring machine.

Bendix backs up the most complete line of numerical control equipment with the best and most complete service organization in this country. From application engineering through tape preparation, customer training and field service, Bendix has had more teamwork experience than has any other electronic controls manufacturer in the field.

Only at Bendix can the machine tool builder and user find everything he needs for numerically controlled manufacturing. Why not investigate Bendix PACKAGED PRODUCTIVITY today.

FERRANTI FI-22 COORDINATE MEASURING MACHINE. Checks workpieces up to ten times faster than conventional methods. Direct and continuous readout (in ¾-inch figures) of hole center locations with one-set-up simplicity. Accuracy of ±0.001″ over entire 15″ x 24″ range.



THE Bendix CORPORATION

Industrial Controls Section

21820 Wyoming, Detroit 37, Michigan

For additional information on Bendix Numerical Control and Measuring Equipment, please write to Bendix at the above address.

Circle 669 on Page 19

HANNIFIN
has a faster,
more rugged
AIR MOTOR

Truly a convenience package, the Hannifin Air Motor combines a rugged, low-friction, double-acting air cylinder with a solenoid valve. Ample air passages permit rapid cycling. Built-in speed controls make it possible to slow either or both strokes. Mounting dimensions interchange with most existing applications. "Off shelf" delivery in "standard" strokes. Bulletin 215—free on request—describes this new product.

PARKER HANNIFIN CORPORATION
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
HANNIFIN COMPANY
A DIVISION
541 South Wolf Road
Des Plaines, Illinois
3155-PH

Circle 670 on Page 19

COMPACT, four-axis numerical positioning control system has been developed by the Electronics Div., Rheem Mfg. Co. Suitable for machine tool applications, the unit is said to attain accuracies within 0.0001-inch. In control of a precision boring machine, the system can simultaneously position a worktable horizontally, control rate of feed of a boring tool, and control the radius of cut with the spindle rotating. Information on a planning sheet, prepared from a part blueprint, is put on tape by means of a tape preparation unit. The keyboard-type unit punches holes automatically on 1-inch wide tape. The electronic system shown then reads the tape and transmits signals to the machine elements. Modular construction of the controls for each axis allows easy replacement, as shown in close-up of control console.

Inc., as corporate secretary; and **E. R. Rath,** Fluid Controls Institute Inc., as executive secretary.

The membership of Fluid Controls Institute Inc. includes leading manufacturers of automatic regulator valves, control valves, solenoid valves, safety and relief valves, space heating specialties, steam and gas traps, and steam heating pumps.

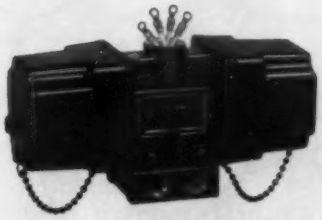
Other business conducted at the meeting included a discussion of forecasting and its application to the solution of management problems, and Section meetings devoted to the development of voluntary standards.

SPOTLIGHTING PEOPLE

John F. Ducey appointed director of acquisitions at American Brake Shoe Co. . . . **Kenneth Brierley** named general manager of the Fall River, Mass., Div., and **John H. Hagen** named general manager of the Rubicon Div., both divisions of the Industrial Products Group, Minneapolis-Honeywell Regulator Co. . . . **Robert Potter** elected chairman of the board of directors and **J. Ralph Patterson** elected president and chief executive officer of E. W. Bliss Co. . . . **John R. Strom** appointed technical director of Ransohoff Co. . . . **Dennis D. Willard** named manager of Advanced Computer Laboratory for Ampex Data Products Co. . . . **Stewart B. Ashton** appointed chief engineer of C. I. Hayes Inc. . . . **Frank L. Magee** elected chairman of the board, **Lawrence Litchfield Jr.** named president, and **I. W. Wilson** appointed chairman of the Finance Committee, all at Aluminum Co. of America. . . . **Walter Hanstein Jr.** named associate director of engineering at Burroughs Corp. . . . **Richard A. Denton** appointed vice president of the High Vacuum Div. at Elion Instruments Inc. . . . **John H. Howard** named director of the Data Processing Group of the Office Equipment Manufacturers Institute. . . . **Harold F. Wiley** appointed vice president of Consolidated Electrodynamics Corp. . . . **Frank Tenczа** named chief engineer of Robins Engineers Div. at Hewitt-Robins Inc. . . . **Donald A. Potter** elected vice president of Stewart-Warner Corp. . . . **T. Webster Matchett** named general manager of the Pershing Rd. plant in Chicago, **George Ramsden** appointed general manager of the Caldwell plant in Chicago, and **Gerald A. Stone** named general manager of the North Central Div. in Minneapolis, all at Link-Belt Co. . . . **Kenneth W. Clarke** promoted to product manager for Heavy Industrial Systems and **Richard J. Bazard** promoted to systems engineering manager, both at Datex Corp. . . . **J. Bryan Straley** elected president

SAVE TIME, AIR, MONEY

with PARKER-HANNIFIN One-Source Engineering



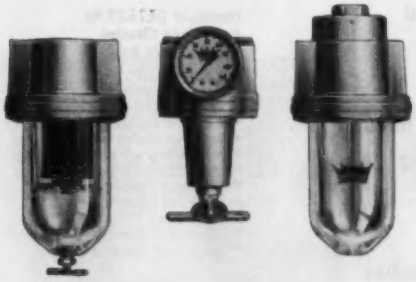
DUAL SOLENOID, 4-WAY

CAM, 3-WAY

PRESSURE, 3-WAY

HAND, 4-WAY

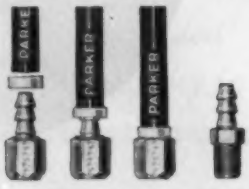
Use flow factors as money-savers – your Parker-Hannifin man can show you how. They help you to avoid "over-sizing" your valves. Hannifin's new Valve Finder gives "C_v" ratings for every valve in the line, makes it possible for you to take full advantage of the extra air-flow capacity in Hannifin air valves. Get your copy today.



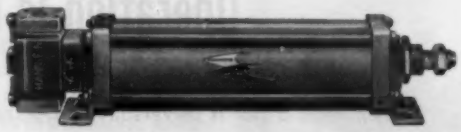
You will save both air and money with Hannifin "Crown" air line filters, pressure regulators and lubricators. Let your Parker-Hannifin man show you how they pay for themselves by making it possible to get all the air flow you need at the exact pressure that will best do the job. "Crown" filters and lubricators will bring further savings through reduced equipment maintenance.

Low friction, long packing life are money-saving features of the Hannifin Series "A" pneumatic cylinder, available in a full range of mounting styles and from 1½" to 14" bore, strokes to 20 feet. Hannifin cylinder application data and charts make selecting the right Series "A" cylinder easy. Get yours from your Parker-Hannifin man.

Pneumatic systems tube up fast with Parker "Intru-lok" tube fittings. Use them with copper, nylon or "Parker-POL" polyethylene tubing. Just insert the tube and tighten the nut for a leakproof "bite-type" joint.



Another time-saver is "Push-lok", the Parker hose-and-hose-fittings combination for pressures to 250 psi. No tools needed. Just push this hose on these hose fittings. They won't blow off, ever, not at twice 250 psi.



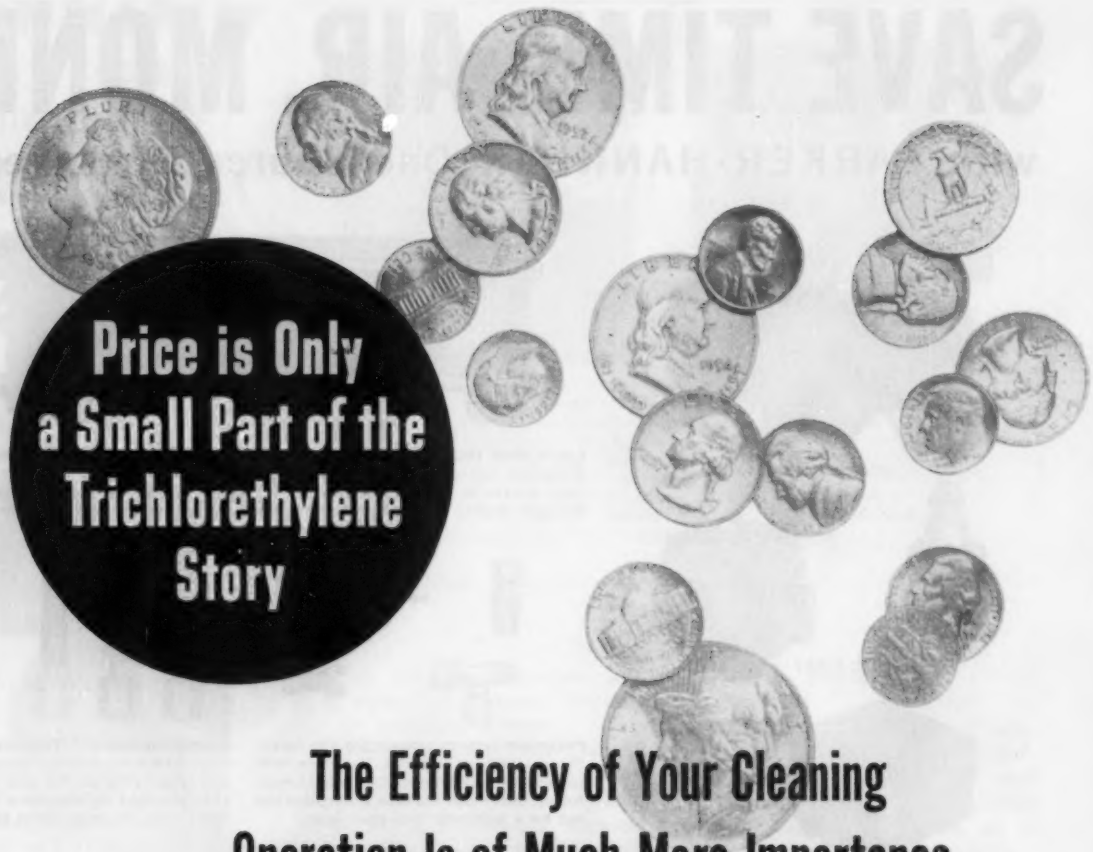
One air line conection installs the Hannifin Air Motor... an integral solenoid valve controlling a fast, rugged double-acting air cylinder. Built-in speed controls adjust piston speed in either or both directions.

Your pneumatic system shapes up faster at the design stage when one man can discuss with you every component you'll need. But have you realized how much your Parker-Hannifin man can save you in money and air?

Just for instance... your valves don't have to be ¾" just because the cylinder size you select comes with ¾" ports. Your Parker-Hannifin man chooses valve types and sizes to suit the air flow you'll need. He'll show you, too, how pressure control saves money and air, how a smaller lubricator is often a more efficient lubricator, and other money saving ideas. Then he'll show you ways to "tube up" and "hose up" a leakproof pneumatic system quicker, neater and at lower cost.

Call your nearest Parker-Hannifin sales office, or write direct for complete information.

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
HANNIFIN COMPANY
A DIVISION
541 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS



Price is Only a Small Part of the Trichlorethylene Story

The Efficiency of Your Cleaning Operation Is of Much More Importance

Detrex Perm-a-clor is universally recognized as a premium grade solvent, selling at regular price. *There is none better.*

Buying from questionable sources or the use of unproved solvent can result in an inferior finishing operation which actually costs money instead of saving it.

One sure way to save *real* money on trichlorethylene is through an expert engineering analysis of the overall degreasing operation—your equipment, your methods, the proper instruction of your people.

Detrex engineers have been making such operational studies for more than 30 years. In many, many instances they have set up a program that has reduced solvent consumption by 15% to 25%. They would like to help you.

Depend on DETREX for Every Metal Cleaning and Processing Need

- PERM-A-CLOR NA (Trichlorethylene)
- Solvent Degreasers
- Ultrasonic Equipment
- Industrial Washer
- Phosphate Coating Compounds
- PAINTBOND Compounds
- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rustproofing Materials
- Extrusion and Drawing Compounds
- Spray Booth Compounds

Write for Dr. C. E. Kircher's informative article: "How to Get the Most Out of Solvent Degreasing".

DETREX CHEMICAL INDUSTRIES, INC.

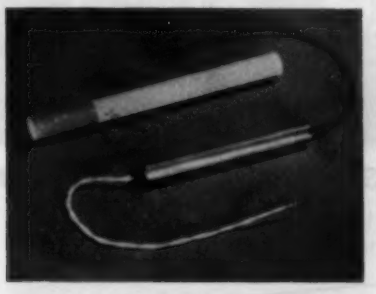
Box 501, Dept. A-1160, Detroit 32, Michigan

World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

of Reeves Instrument Corp. . . . **M. Claude Schuler** appointed general manager of the Stapling & Stitching Div. at Bostitch Inc. . . . **Branin A. Boyd** named chief electrical engineer of Trans-Weigh Co. . . . **William S. Buzzard** appointed chief technologist for the Industrial Instruments Div. at Fischer & Porter Co. . . . **Peter C. Sundt** named administrative assistant to the executive vice president of Mandrel Industries. . . . **Dause L. Bibby** appointed president of the Remington Rand Div. of Sperry Rand Corp. . . . **Merle E. Snyder** named manager of Equipment Development of Auerbach Electronics Corp. . . . **Paul Cherkas** elected president of Measurement Control Devices, subsidiary of Schaevitz Engineering.

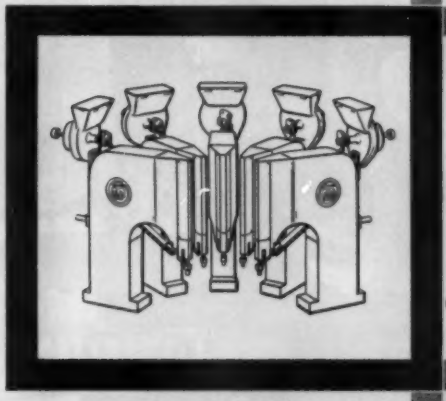
SPOTLIGHTING PLANTS

A. O. Smith Corp. will build an advanced research center at Middleton, Wis. The new laboratories will be devoted to advanced fields in solid state physics and physical chemistry of materials. . . . **Custom Abrasive Products Co. Inc.** is the name of a new company formed to provide technical services to the metal finishing trades in the Middle Atlantic and New England states. It will concentrate on giving data on the limitations, advantages, and applications of various media and compounds in the field of metal cleaning, coloring, prepara-



ELECTRO-OPTICAL RELAY developed by Raytheon Co., has a conductance on-off ratio of 1,000,000 to 1, and is capable of speeds up to 100 operations per second. The device is said to be designed to replace relays, potentiometers, and commutators in many applications. The unit has a light source in the control end which, when excited, actuates a photo-conductor in the signal end, allowing either ac or dc information to pass. One of the features of the unit is its ability to switch without introducing transients in the signal circuit.

NEW "BUILDING BLOCKS" . . . for automatic riveting

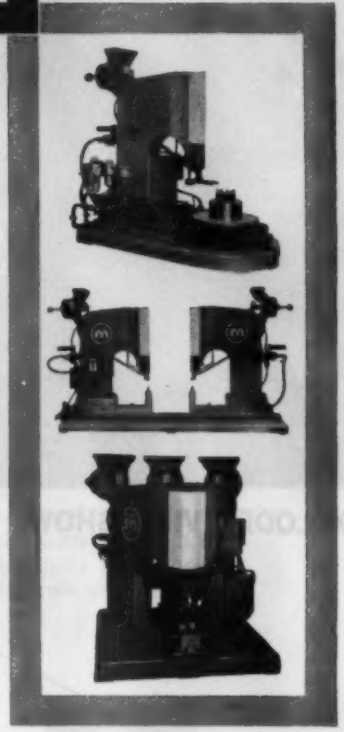


Milford's Models 56 and 57 offer unlimited flexibility in automatic assembly

The narrow wedge shape of Milford's new air-actuated riveters permits unusually close riveting. Both models can be combined with sliding-fixtures, indexing tables or similar attachments to give greatest flexibility of assembly. Air-operated toggle action assures fast and safe action. Model 56 handles tubular rivets from ⅛" diameter x ⅝" length; Model 57 from 3/16" diameter x 3/4" length.

Group these new "Building Blocks" to suit your own production needs. Use them singly, in pairs, in threes, fours or even fives. Multiple riveting is the newest answer to reducing production costs.

For more new ideas, tips and technical data on tubular rivets and rivet-setting machines, ask your Milford Representative for a look at Milford's new MANUAL OF MODERN RIVETING PRACTICE.



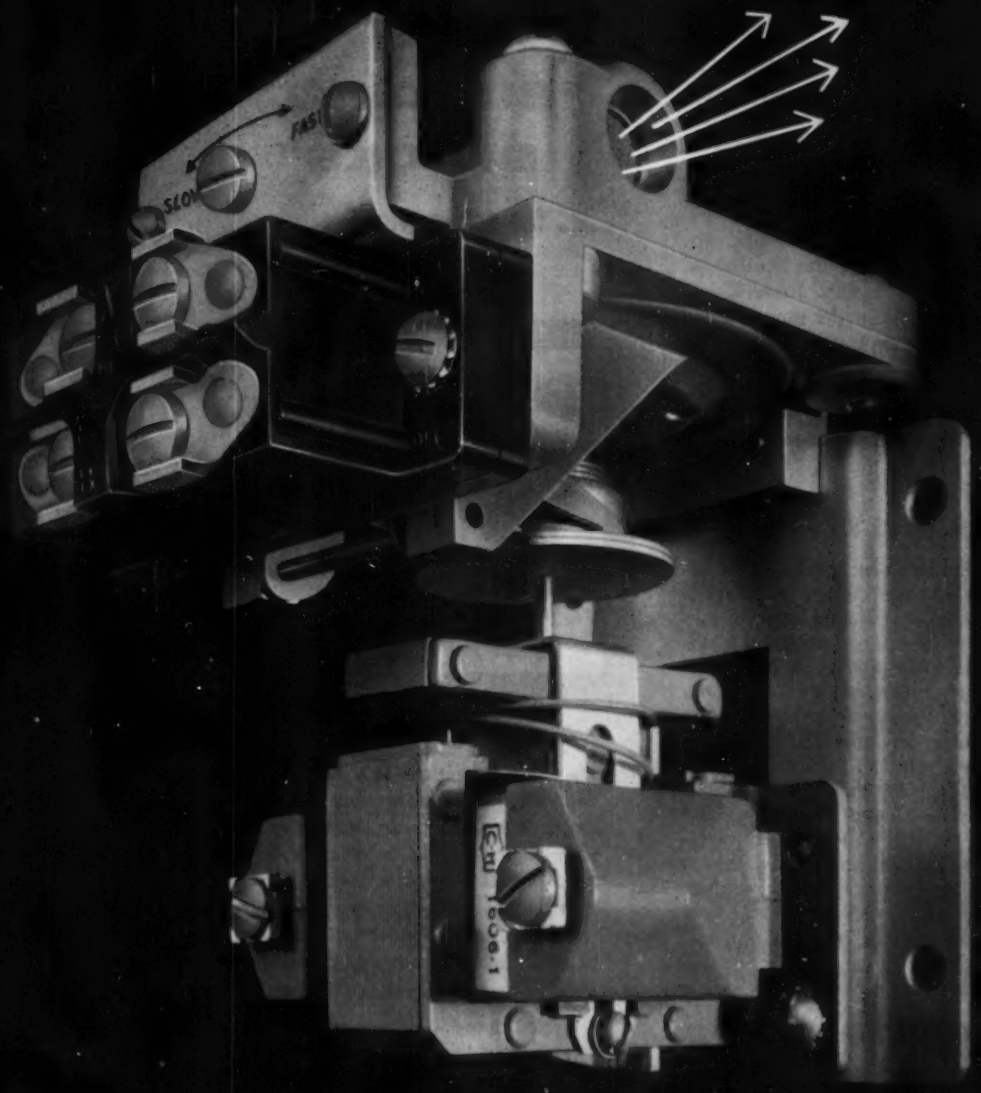
THE MILFORD RIVET

MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

Circle 673 on Page 19

NO CHECK VALVE! Air cleans filter as it exhausts through the vent. No check valve to clog and cause trouble.



EXPLODED VIEW SHOWS HOW NEW DIAPHRAGM DESIGN ELIMINATES CHECK VALVE

New! A Cutler-Hammer one-minute pneumatic timer that eliminates the troublesome check valve!

Unique diaphragm design makes timer more accurate and dependable than any other

The new Cutler-Hammer one-minute Pneumatic Timer, by eliminating the conventional check valve, does away with failures caused by dust.

Using a silicone diaphragm, this timer pulls fresh air in through a filtered vent, and on the exhaust stroke blows away any dust that may have collected on the surface of the filter. No chance for dust to affect accurate timing or make the timer inoperable. The silicone diaphragm works equally well 150°F above zero or 45°F below zero.

No other timer is more accurate. It adjusts easily from .2 seconds to 60 seconds with a 7½-turn screw that provides precise adjustment to the desired time setting. All you need is a screwdriver. And, it can be changed from "on delay" to "off delay" in seconds. Smallest electrical dimensions of any one-minute timer, too. Call your Cutler-Hammer distributor for full details or send for Publication L071-W283.

What's new at Cutler-Hammer?

You can see the big change at Cutler-Hammer wherever you look. New, better products. New, expanded engineering staff and facilities. New added plant capacities. All done to help you meet the big opportunities of this decade.

If you're planning ahead, we'd like to show you how our talents and experience in electrical control could help you. Contact the nearest Cutler-Hammer sales office.

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

Circle 674 on Page 19

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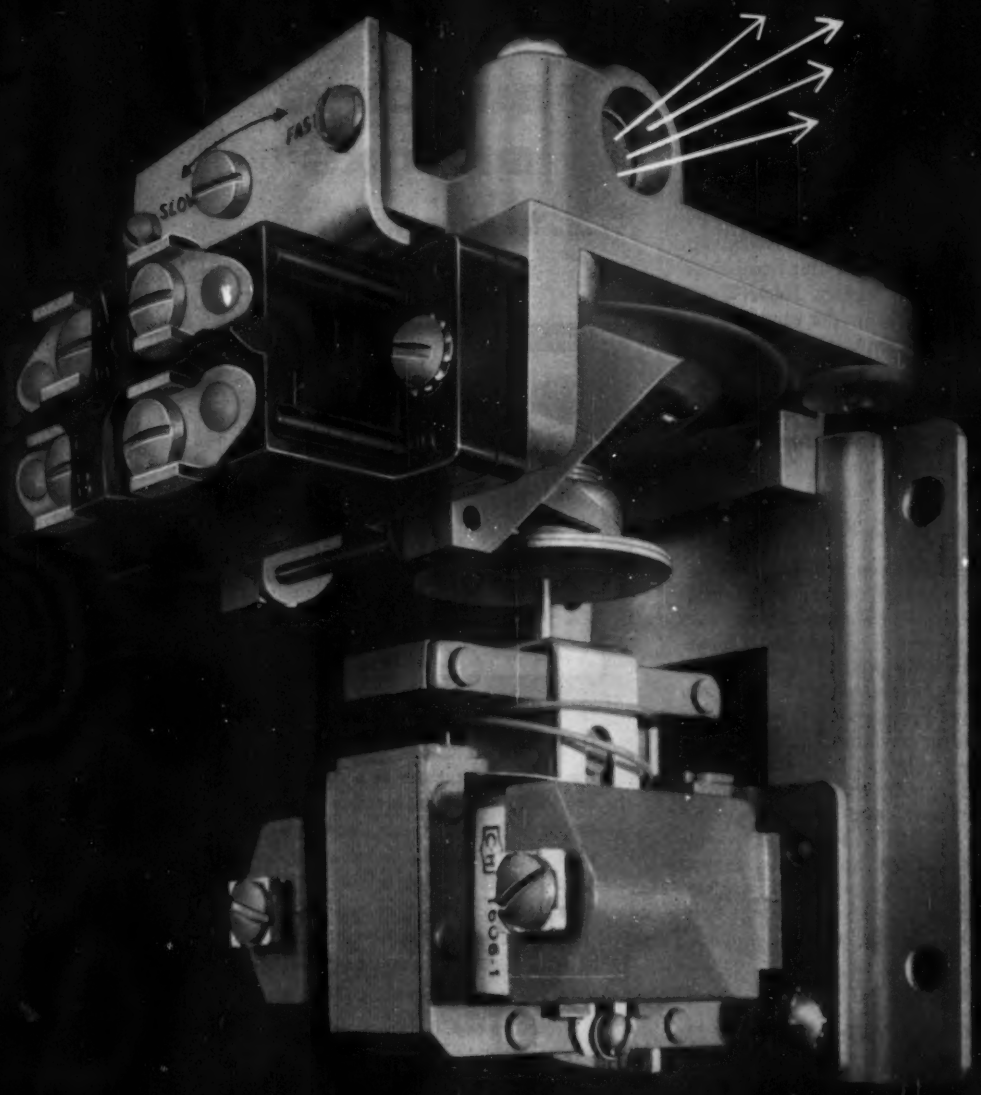

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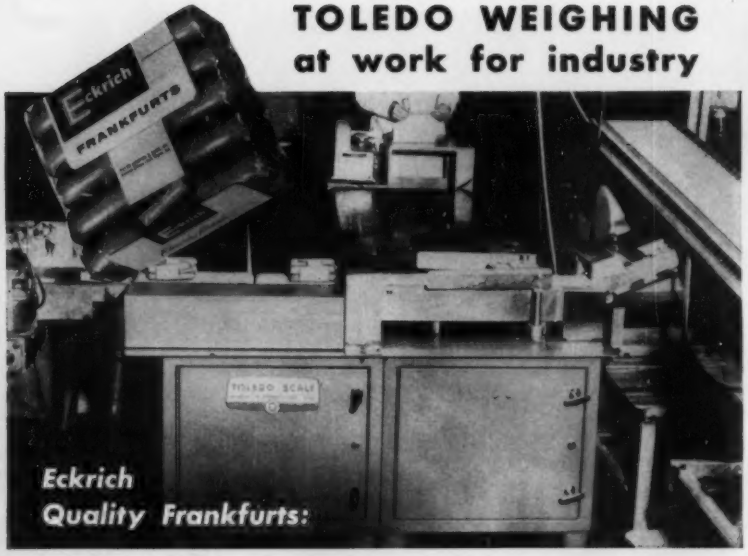
Circle 674 on Page 19

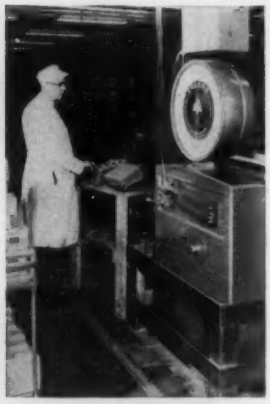
TOLEDO WEIGHING at work for industry



How TOLEDO Automatic Checkweighing assures accurate package weights, speeds production!

With the squeeze on meat packing profits, the drive for lower costs and better efficiency never ends. Peter Eckrich and Sons, Fort Wayne, Indiana, is a case in point.

ECKRICH has installed a Toledo 9457 Checkweigher (shown above) to automatically (1) weigh each 1 lb. package of frankfurts, (2) reject those over or under a tolerance zone within an accuracy of 1/32 oz., and (3) count the o.k.'s, overs and unders. This Toledo's accuracy and dependability enable Eckrich to report average production through the checkweigher at 55 packages per minute. And the o.k., over and under count guides the stuffing operation to assure most uniform control of frankfurt weights.



TOLEDO 2151 FLOOR SCALES in Eckrich's shipping room help fill salesmen's orders on a production basis. Each scale has an input station for imprinting the route number; a control station for taring of weight of the rack. Even though the items making up the order are loaded on the rack cumulatively, each item is automatically listed on the tape at its net weight.

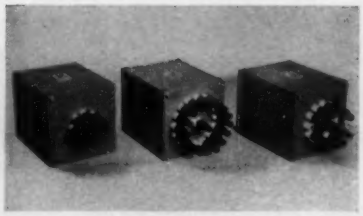
In Eckrich's shipping room three Toledo 2151 Floor Scales are equipped to transmit weights to machines that list individual weights of items on tape as racks are loaded, giving both speed and accuracy in filling orders beyond any method previously used.

Toledo Scale engineers will assist you in developing more efficient, cost-saving weighing methods, based on the wide selection of Toledo industrial scales, or development of modifications or custom engineered units for your needs. Write and tell us about your problems. TOLEDO SCALE, Toledo 12, Ohio, Division of Toledo Scale Corporation. Toledo Scale Company of Canada, Ltd., Windsor, Ontario.

SERVICE Factory-Trained 249 Cities

TOLEDO® *headquarters for weighing systems*

• FLOOR AND TRACK SCALES • BENCH AND PORTABLE SCALES • OVER-UNDER SCALES • WEIGHT PRINTING • OVERHEAD TRACK SCALES • COUNTING SCALES • TRUCK SCALES



IGNITER CONTROL can automatically fire a network of up to 32 gas burners in ovens, furnaces, boilers, and heat-treating systems within 3 seconds. When the unit, developed by Protection Controls Inc., is energized by a *Start* button, a motorized double-end shaft rotates a wiping contact against a series of stationary contact tips—one for each burner in the system. This causes a high voltage impulse from an ignition transformer to be fed to each pilot spark electrode, which ignites a gas-air mixture at each burner position. A timing unit can be incorporated to activate the motor at any desired intervals for continuous, intermittent, or variable timed ignition.

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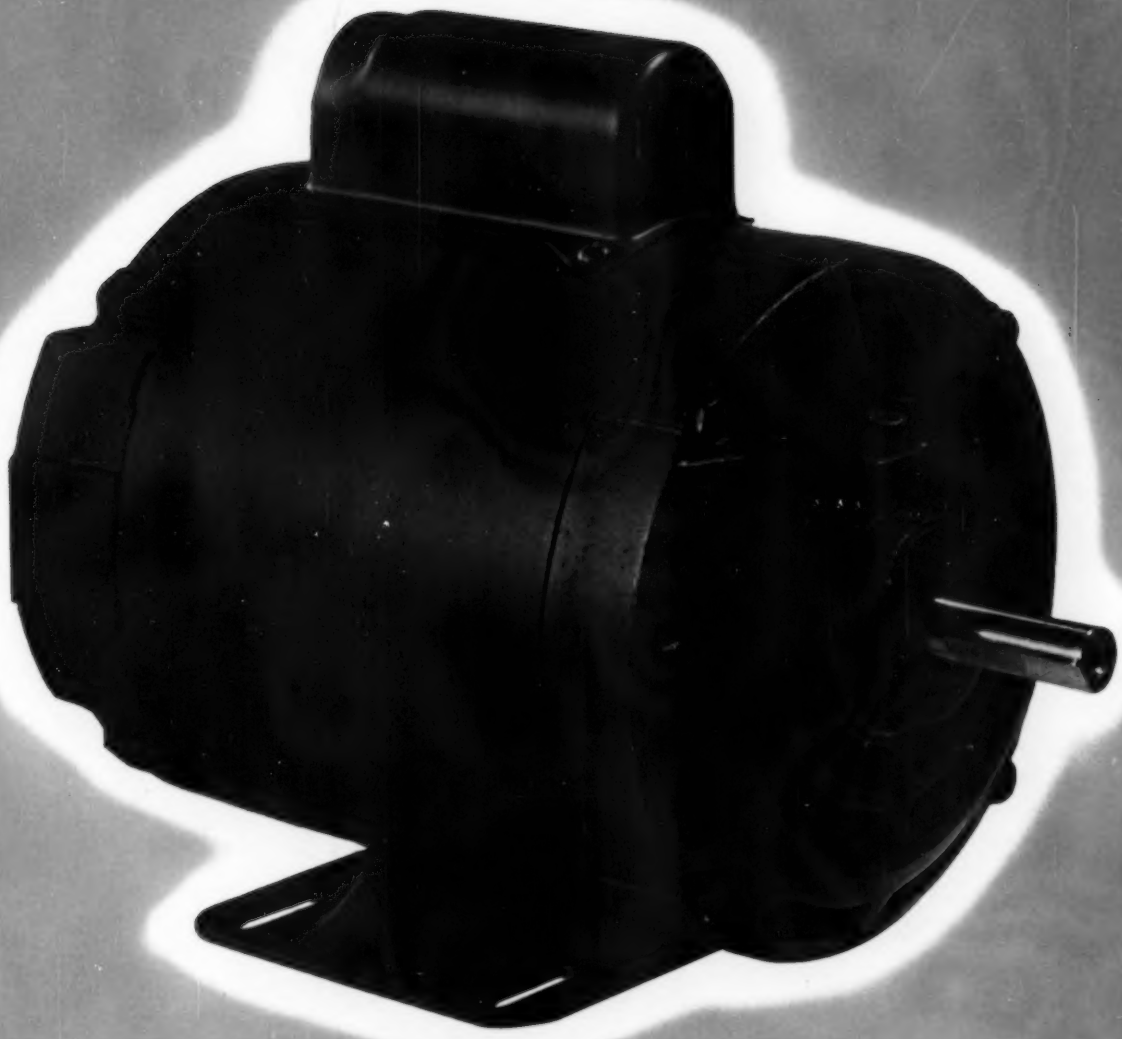
tion for plating and finishing of castings, screw machine products, and stampings. . . . **Minneapolis-Honeywell Regulator Co.** has formed a Special Systems Div. for developing, installing, and servicing specialized control systems. Headquarters will be at Pottstown, Pa. . . . **Ampex Corp.** and **Telemeter Magnetics Inc.** are planning a merger, subject to the approval of share owners of both companies. Ampex will be the surviving corporation. . . . **Wagner Electric Corp.** has started production of standard fractional horsepower motors at its new manufacturing plant at Brinkley, Ark. The 90,000 sq ft building is designed for continuous-flow layout of machines, assembly lines, and testing equipment. . . . **McKay Machine Co.**, manufacturer of sheet and coil processing equipment, has purchased the Berkeley Co., producer of automatic arc welding equipment. McKay Machine is also proposing to purchase the Federal Machine & Welder Co., and its subsidiary, Berkeley-Davis Inc. . . . **Daystrom Inc.** announced that it is moving the engineering, manufacture, and sales of potentiometers to its Military Electronics Div. at Archbald, Pa. The facilities and labor capabilities at Archbald will permit the complete fabrication and assembly of potentiometers without requiring the subcontracting of labor to a diversity of vendors. . . . **Space Age Industries Inc.** is the name of a newly-formed company

Circle 675 on Page 19

Circle 676 on Page 19→



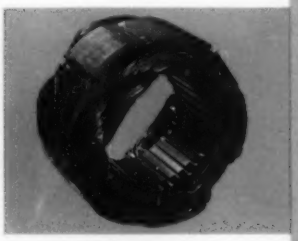
A NEW Duty Master FHP.

for heavy-duty industrial use

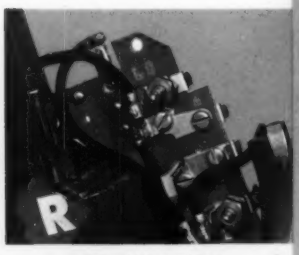
RELIANCE ELECTRIC AND ENGINEERING COMPANY

MASTER ELECTRIC COMPANY DIVISION

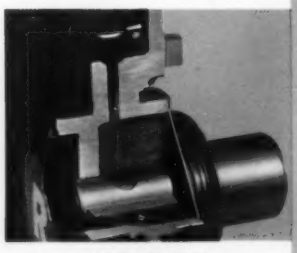
A NEW Duty Master FHP.



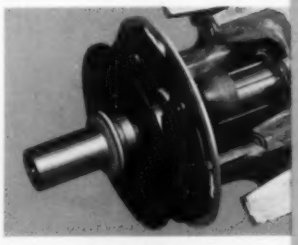
PROTECTED STATOR



TERMINAL BOARD



SLEEVE BEARING



CENTRIFUGAL CUT-OUT

TOUGH... COMPACT... COOL!

A motor that combines new, most-wanted features at no extra cost

Duty Master:

This motor is tough all over . . . deliberately designed for heavy industrial duty. Frame is rolled from steel—end shields cast from an aluminum alloy specifically selected for strength. Ball bearings are double-shielded, with lubricant packed into the bearing for life. Sleeve bearings are steel-backed and babbitt-lined for low friction and long wear. "Permawick" oil retaining material provides maximum lubrication to these bearings. Rotor is pressure-cast from high purity, low-resistance aluminum. Varnish impregnated stator resists moisture . . . and adds strength to windings.

Duty Master:

More power per pound . . . simple installation, 33% lighter than other preceding motor designs. Good design and materials make the difference. Makers of motor-driven products save on shipping and handling costs. Duty Master's light weight and small size make possible lighter, less complex mounting on equipment. Terminal board provides easy power connection in the front end shield. Cover plate quickly removable. Motor rotation easily reversed by interchanging slip-on connections.

Duty Master:

Up to 10% cooler than other comparably rated motors . . . yet gives you maximum protection. High load capacity results from new, effective ventilation of critical heat sources. Laminations, coils and rotor are literally rinsed with cooling air through new end shield design. In totally-enclosed, non-ventilated motors, the fan, cast integrally with rotor, circulates the air within the motor at a rate appropriate to efficient transfer of heat to motor frame and end shield. And load carrying capacity of the totally-enclosed fan-cooled motor is increased by a fan and shroud directing air over the frame and end shield.

Duty Master:

Quiet . . . Smooth . . . Positive. Resilient mounting composed of metal-rimmed, rubber-cushioning rings that encircle the bearing hubs on each end and support the motor. Motor can be mounted in any position. Single phase starter winding circuit automatically opens at 80% of full load speed. Action is quiet and positive.

Available now in 48 and 56 frame sizes, from conveniently located stocks. Duty Master FHP. is made in 1/8, 1/6, 1/4, 1/3, 1/2 and 3/4 hp. capacitor-start, split-phase and polyphase for 48 and 56 frames; repulsion-start induction-run in 56 frame. Your Reliance Sales Engineer or Distributor has all the facts at his finger tips. Call him or write for Bulletin B-2514. It will be sent to you promptly. B-1075

PRINTED IN U.S.A.

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 17, OHIO

Canadian Division: Toronto, Ontario

Sales Offices and Distributors in principal cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems

in Los Angeles. The firm will specialize in research and production of electromechanical transducers and associated instruments for use in the aviation, missile, and automation industries. The firm will also be active in systems development for the automation of industrial processes. . . . **Westinghouse Electric Corp.** has announced that its Welding Dept. will now be called the West-ing-arc Dept., because the products are manufactured on the electric arc principle. . . . **Perkin-Elmer Corp.** announces construction of a two story building, located on a 16-acre site in Wilton, Conn. The engineering and advanced research and development groups of the Electro-Optical Div. will be housed in the new building. . . . **Perkin Electronics Corp.** is the new name of Perkin Engr. Corp. Reason for the change is to indicate more accurately the company's main activity, which is the manufacture of electronic equipment.

MEETINGS AND EVENTS

Nov. 7—

Society of Plastics Engineers Inc. Technical conference on plastics and automatic controls to be held at King Edward Sheraton Hotel, Toronto, Ontario, Canada. More information available from society headquarters, 65 Prospect St., Stamford, Conn.

Nov. 8-11—

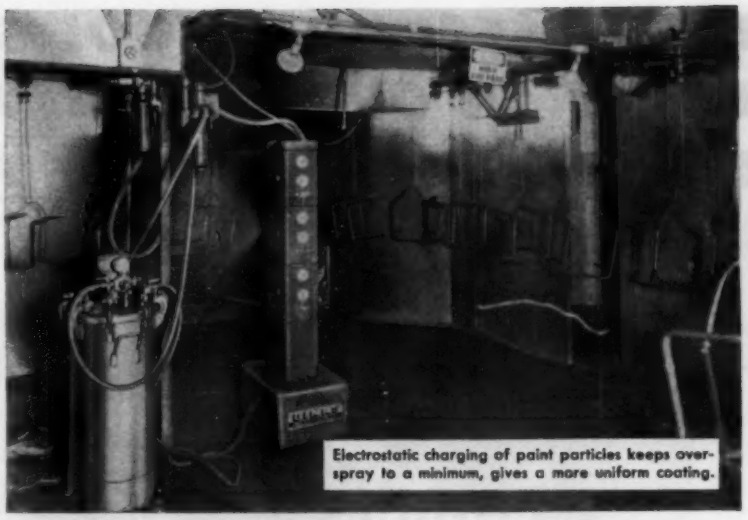
Society of Die Casting Engineers. Exhibit and technical conference to be held at the Artillery Armory, Detroit. Additional information from society headquarters, 19382 James Couzens Highway, Detroit 36, Mich.

Nov. 14-16—

Steel Founders' Society of America. Technical and operating conference to be held at Hotel Carter, Cleveland. Additional information available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 14-17—

Conference on Magnetism & Magnetic Materials. Sponsored by AIEE, AIME, AIP, IRE, and ONR. To be held at New Yorker Hotel,



Electrostatic charging of paint particles keeps overspray to a minimum, gives a more uniform coating.

at Lu Van, Inc., furniture manufacturers, Belding, Mich.

Binks modular electrostatic spraying ups finishing production 40%

"Our finishing production increased 40% since installing a Binks electrostatic spraying machine," reports Mr. A. G. Van Syoc, Jr., president of Lu Van, Inc., fast growing manufacturers of contemporary furniture.

"Records also show," states Mr. Van Syoc, "a 15% cut in finishing costs and a 10% savings in paint. We feel that in every regard our Binks machine has vastly improved efficiency, product quality and operational flexibility."

Installation costs cut

Use of the existing Binks spray booth kept installation costs at a minimum. Designed for Binks integrated spraying systems the water-wash booth, formerly used for manual spraying, was incorporated in the automatic set-up without costly modification.

Lower cost, quality finishing

Thousands of manufacturers, like Lu Van, have increased both quantity and quality of spray finishing production with the help of Binks' engineers and equipment. They can help you, too. Whether your need is for a single unit or a completely integrated, highly automated system, Binks has the knowledge and exact machines to speed up your operation and produce superior finishes.

Free finishing analysis

Binks will show you the application method best suited to your needs. An analysis is made under production conditions with your products and your finishing and coating materials. You're not obligated in any way. Just call your Binks branch office or write direct to the address below.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

Binks *EVERYTHING FOR SPRAY PAINTING*

SPRAY GUNS

AIR COMPRESSORS

NATIONWIDE SERVICE

Binks Manufacturing Company
3132-40 Carroll Avenue, Chicago 12, Illinois

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←Circle 677 on Page 19

Circle 678 on Page 19

EVERY SECOND A TOOL STANDS IDLE WHILE AN OPERATOR LOADS OR UNLOADS COSTS YOU MONEY

Any one of these BELLOWS-VALVAIR Air-powered Work Feeders can cut that idle time in half!

Need close tolerance indexing?

Model BRET-13B
13" diameter top
Factory set for either 4, 6, 9, 12 or 18 stations

Model BRET-26C
26" diameter top
Factory set for either 4, 6, 9, 12 or 18 stations (may be ordered for a maximum of 36 stations)

Extremely close indexing tolerances . . . that is the extra feature built into this group of Bellows-Valvair Rotary Index Tables. Built to rigid standards of workmanship and material, they provide a quality of performance unmatched in their field. These units, too, have built-in controls to regulate the indexing speed; they are complete units, just make the necessary electrical and air supply connections; they may be easily synchronized with other Bellows-Valvair equipment to build completely automatic, high speed special purpose machines.

Need high speed work positioning?

Model BRET-10C
10" diameter top
Adjustable for 4, 6, 8, 12 or 24 stations

Model BRET-22C
22" diameter top
Factory set for either 4, 6, 9, 12, 18 or 36 stations (may be ordered for a maximum of 72 stations)

These Rotary Feed Tables position work pieces with high accuracy, at a rate to match machine efficiency. The units are complete; require only mounting, attaching electrical connections, coupling with air supply. They may be mounted in any position thereby allowing a wide range of application for feeding a variety of work pieces in very simple or complex machine or processing systems. Indexing speed is easily controlled . . . two speed control screws on the Electroaire Valve® may be adjusted to regulate the rotating speed of the table top. Oversize table tops may be attached to the standard top.

How about 2-position shuttle feeding?

Model TF-60D
Table top is 8" x 26"
The two work stations may be adjusted from 3-5/16" to 6-1/8" apart

Removing a finished work piece and positioning a raw part at one station while a production operation is being performed at the other station . . . this is what the Bellows-Valvair Shuttle Feed provides and, by doing so, unloading and loading time does not interrupt the machining operation. Speed of movement of the top is easily adjusted by the control screws built into the Electroaire Valve controlling the Bellows Air Motor®. The unit is complete when received, ready to install and operate. And, it may be synchronized with other Bellows-Valvair equipment . . . a feature of all Bellows-Valvair "Controlled-Air-Power" Packaged Units.

872C

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

Bellows-Valvair, Division of IBEC, Akron 9, Ohio

Please send me full details on Bellows-Valvair Air-powered Index and Work Feeders. AU-1160

Name _____

Company _____

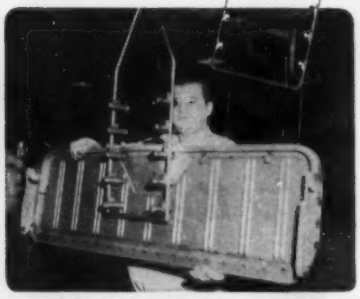
Address _____

NEW!
FASTER
RACKING

for conveying all Sizes and Shapes of Stampings, Parts, etc.

ERIEZ

permanent non-electric
ERIUM-POWERED*
MAGNA-
RAX



GET INCREASED CONVEYING EFFICIENCY. Magna-Rax magnetic power holds parts firmly in place while being conveyed . . . loading and unloading is faster . . . easier! One model will handle hundreds of sizes and shapes of parts . . . Magna-Rax are ideal for assembly line operations, where parts are conveyed from one point to another. Magnetic strength firmly holds parts while many operations such as tack off, dipping, spray painting, coating, degreasing, washing, inspecting, etc., are being performed . . . no need for special holes, lips, etc., on the parts as a means of holding.

Ideal for overhead or monorail systems. Rust and corrosion resistant . . . unaffected by temperatures up to 750°. Available in most any size and shape and with any number of Holding Magnets.

**Erium — an exclusive, high quality permanent magnetic power source specifically designed and energized by Eriez.*

Write for data on this exciting new product.
Eriez Mfg. Co., 119-LA Magnet Drive, Erie, Pa.

ERIEZ

Circle 680 on Page 19

New York City. More information available from R. C. Fletcher, Bell Telephone Labs., Murray Hill, N. J.

Nov. 14-18—

American Society of Tool and Manufacturing Engineers. Western Engineering Conference & Exhibit; exhibits will be in the Memorial Sports Arena and the technical sessions will be held at the Ambassador Hotel, Los Angeles. More information from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Nov. 22—

Manufacturing Chemists Association. Semi-annual meeting and midyear conference to be held at Statler Hilton Hotel, New York City. Additional information available from association headquarters, 1825 Connecticut Ave., Washington 9, D. C.

Nov. 27-Dec. 2—

American Society of Mechanical Engineers. Annual meeting to be held at Statler Hilton Hotel, New York City. More information from society headquarters, 29 West 39th St., New York 18, N. Y.

Nov. 28-Dec. 2—

American Society of Mechanical Engineers. National Exposition of Power and Mechanical Engineering will be held at the Coliseum, New York City. More information avail-

STATIC CHARGES on synthetic yarns and fabrics are measured during production by static voltmeter. Device is useful in measuring effectiveness of antistatic preparations applied to the materials. The voltmeter uses a roller electrode to measure static charges from 0 to 5000 v on individual threads as well as complete fabrics. The density of the charge is measured and the effectiveness of the antistatic preparation checked. The instrument, made in Switzerland, is distributed in the United States by Fabrionics Corp.

FASTER SPEEDS, SHORTER LINES
with
MAGNETIC
CONVEYING SYSTEMS

ERIEZ

permanent non-electric
ERIUM-POWERED*
MAGNA-
ROLLS

At this Westinghouse plant in Athens, Ga., cold rolled sheets are picked up by Eriez lifting magnets, and raised against Eriez Magna-Rolls which in turn feed them to a conveyor. This procedure eliminated a manual operation, and assures unvarying accuracy as well as dependable automated performance.

Get peak production with peak conveyor speeds. Powerful MAGNAMATION components positively hold, control, elevate, change direction flow of ferrous materials ranging from small parts to large sheets. Increase production . . . reduce production costs! For use both with and without belts on many types of conveying lines.

Completely non-electric • Easily installed on new or existing equipment • Low initial cost • No operating or maintenance costs • Various widths, strengths and contours to meet specific needs.

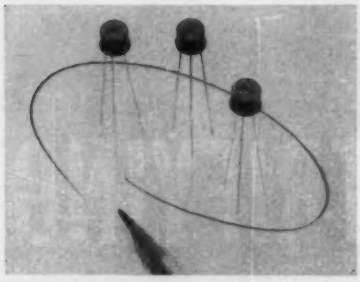
We work closely with design engineers, OEMs, etc. Contact us for assistance.

*Erium—*an exclusive, high quality permanent magnetic power source specifically designed and energized by Eriez.*

Send for free 56-page booklet
"Magnetic Ideas for Automation."
Eriez Mfg. Co., 119-LB, Magnet Drive, Erie, Pa.

ERIEZ

Circle 681 on Page 19



THREE-TERMINAL semiconductor device, designated a silicon unijunction transistor, exhibits open-circuit-stable negative resistance characteristics. Suitable for solid state relay, triggering, and switching circuits in industrial electronic equipment, the device, developed by General Electric Co., has a maximum rms power dissipation rating of 450 mw at a temperature of 25 C.

able from International Exposition Co., 480 Lexington Ave., New York 17, N. Y.

Dec. 4-7—

American Institute of Chemical Engineers. Annual meeting to be held at Statler Hotel, Washington. Additional information from society headquarters, 25 West 45th St., New York 36, N. Y.

Dec. 7—

Seminar on Electro Hydraulic Servo Systems. Co-sponsored by the Milwaukee School of Engineering and the Milwaukee Chapter, Fluid Power Society. The sessions will be held at the school's Hall of Science. Additional information from Mr. Mel Streigel, Milwaukee School of Engineering, Technology Park, Milwaukee 1, Wis.

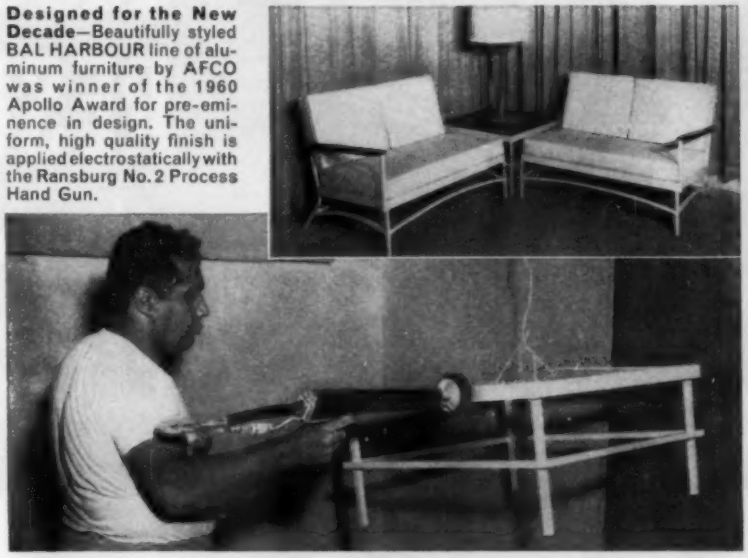
"Speed it up John, some more Indians just arrived."

What Would

75% PAINT SAVINGS

Mean in YOUR Finishing Department?

Designed for the New Decade—Beautifully styled BAL HARBOUR line of aluminum furniture by AFCO was winner of the 1960 Apollo Award for pre-eminence in design. The uniform, high quality finish is applied electrostatically with the Ransburg No. 2 Process Hand Gun.



Faster . . . Cleaner . . . Cheaper—The "wrap-around" feature of the No. 2 Process Electrostatic Hand Gun paints all areas of this type of work from one side only, providing a 75% paint savings and a 700% increase in production volume over former air hand spray.

RANSBURG

Ransburg No. 2 Process Electrostatic Hand Guns are providing a 75% paint savings in the painting of beautiful AFCO aluminum furniture.

AFCO Aluminum Furniture Co., Inc., Miami, Fla., replaced hand spray with two Ransburg Electrostatic Hand Guns. Along with paint and labor savings, quality of the work was improved with greater uniformity. And, production volume was increased a healthy 700%! Formerly, they were painting approximately 100 items a day. NOW, with the faster, cleaner Electrostatic Hand Guns, they paint from 700 to 800 pieces per day. Electrostatic is faster because the "wrap-around" characteristic of Electro-Spray paints all areas of this type of work with a pass from one side only.

NO REASON WHY YOU CAN'T DO IT TOO

Write for information and literature about this revolutionary, new painting tool. See how the Ransburg Electrostatic Hand Gun can save time . . . paint . . . and cut costs in YOUR finishing department. If your production justifies, it'll pay you to investigate Ransburg's *automatic* electrostatic spray painting equipment. Write for our No. 2 Process brochures which show numerous examples of modern production painting in both large and small plants.

RANSBURG Electro-Coating Corp.

Box 23122, Indianapolis 23, Indiana

Circle 682 on Page 19

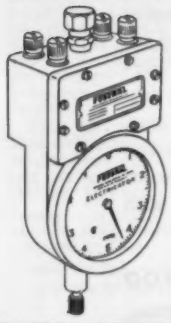
faster gaging . . .

ELECTRIFYING RESULTS . . .

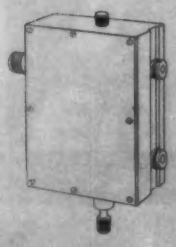
when you use the ELECTRICATOR

Lights show size category. Actual work size is shown on the dial.

WETPROOF STYLE
(For each regular model)



DOUBLE UNIT MODELS
(Four limits, five categories)



ECCENTRICATOR
(For indicating eccentricity, runout, squareness)

There's nothing quite like the Federal Electricator — so easy to apply — so economical — so accurate . . . a Miracle Movement Dial Indicator and two-limit, spindle-actuated switch combined. Use it with tolerance lights in place of your dial indicator for faster, more accurate bench gaging. Use it together with a signal unit for fully automatic inspection or automatic machine or process control.

The Electricator is a high precision unit — switching accuracy is better than 50 millionths on all models. Voltage across the switch is extremely low and switching current is in the order of one milliampere. Therefore, arcing and pitting of contacts is eliminated and accuracy is reliably maintained. The Electricator is calibrated, so it requires only one master.

All Electricator models incorporate the new Federal Miracle Movement which is so wear-resistant . . . so shock resistant . . . you will probably never have to repair or replace it. Six regular models are immediately available from stock. Four different graduations — .0001", .00025", .0005", .001". Prices from $75.

The switching portion of the Electricator is available as a separate unit to operate tolerance lights and/or provide control limits without indicating actual size.

The Federal Eccentricator, a similar type of high precision unit, indicates eccentricity, runout, squareness, etc., *without* being influenced by normal piece-to-piece variations in size.

For more information, write . . .

FEDERAL PRODUCTS CORP.
63911 Eddy Street, Providence 1, R. I.

Ask **FEDERAL** *First*

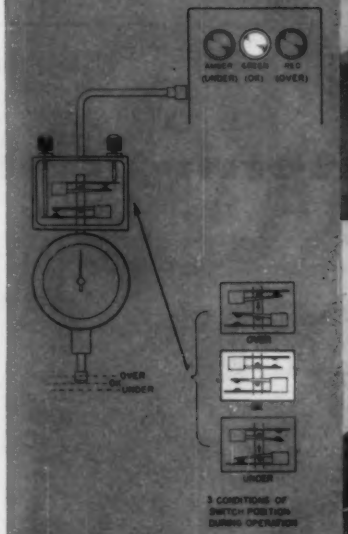
FOR RECOMMENDATIONS IN MODERN GAGES . . .
Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

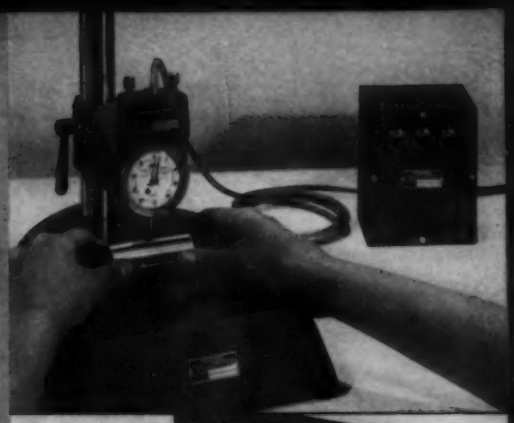
Circle 683 on Page 19

FOR HIGH SPEED BENCH GAGING
(Single or Multiple Dimensions)

It's easy to install the Electricator in place of the dial indicator on your present comparator when you need greater speed. The Electricator eliminates having to make borderline decisions so you get more reliable results . . . and faster results . . . using less skilled help, and with less operator fatigue. Many concerns have up-graded their manual gaging this economical way with great success.

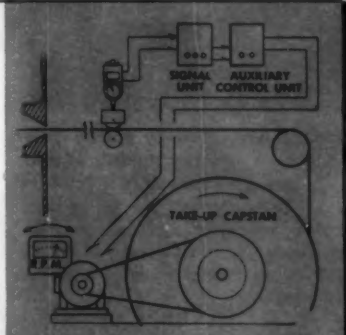
The Electricator offers the most economical way to make multi-dimension checks rapidly and reliably. The signal lights on its control panel instantly show the operator whether the piece is within tolerance or not. No need for operator to look at a group of indicators one by one in order to determine acceptability.

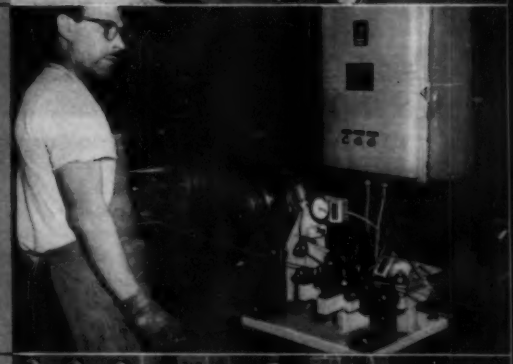




CONTINUOUS PROCESS CONTROL

Because the Electricator is compact, it can be installed easily on most continuous processes to indicate size trend accurately so correction can be made *before* scrap is produced. In many cases, Electricator, working into appropriate signal unit, can be used to *control* size so process automatically produces within tolerance.

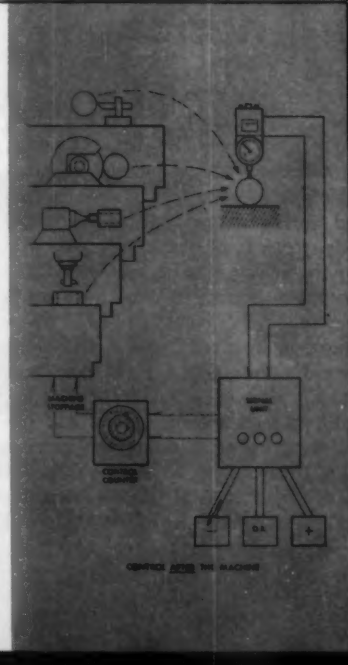


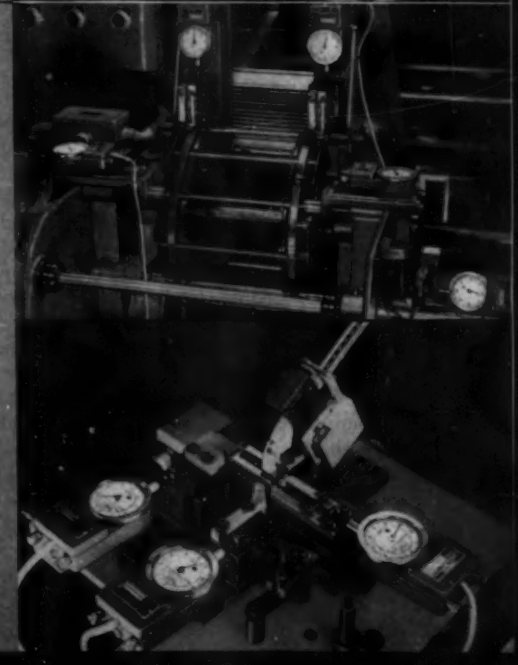


HIGH SPEED AUTOMATIC MULTI-DIMENSION INSPECTION AND MACHINE CONTROL

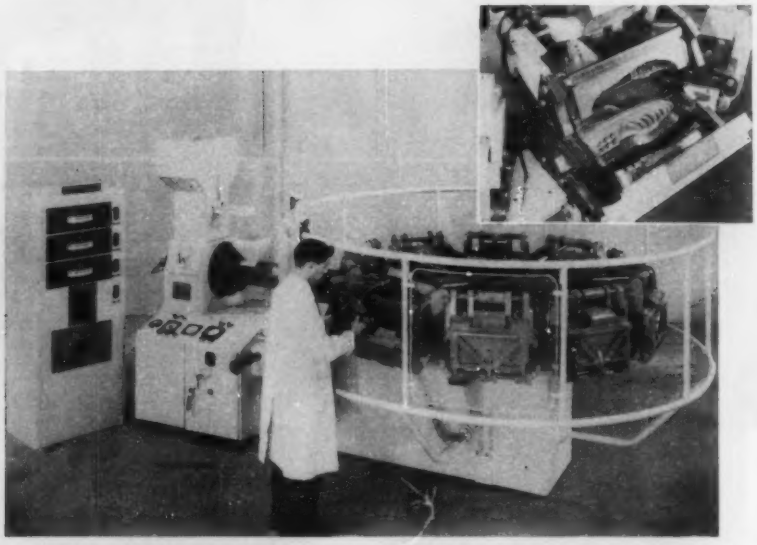
Electricators have rapid response — can gage and sort up to 6,000 pieces per hour, providing up to 5 sorting categories. Wide range adjustment of limits to suit tolerances. Use of low switching voltage and current provides high-reliability performance.

Electricator can also provide post-process machine control in addition to high-speed gaging and sorting. Using simple control counter, gage automatically stops machine when tolerance limits are exceeded.





international scene



Blackburn, England—Injection molding machine developed by Foster, Yates & Tom Ltd. produces all-plastic polyvinylchloride shoes and sandals at rates up to 120 pairs per hour. The machine is basically an extrusion-injection molding machine which uses a revolving screw to convey plastic material through a heating cylinder. An air-operated rotary table moves ten mold fixtures in sequence to an injection head where the plasticized material is forced into each mold. As the table rotates, the mold is cooled by air. Inset shows a completed shoe in an open mold fixture.

Crossbreeding Internationally

SINCE the application of automation is a logical move toward more efficient production, automation cannot be considered as a provincial concept whose use and value is confined to companies in the United States. Wherever production output, product quality, and material utilization need improvement, automation is being and will be applied. It is true that U. S. companies have been leading the world in endorsing and applying automation, but predominance in automation efforts exists only because the need for advanced production techniques was evidenced first in this country. As living standards in other countries rise to a level more comparable to ours, automation will become as much a necessity in Europe, Asia, and Africa as it has here at home.

Although many foreign automation developments have been reported in feature articles and editorial departments of this magazine, adequate coverage has been limited due to space considerations. In recognition of the growing use of automation in countries around the world, the editors of AUTOMATION, through this department, will present notable trends and developments in automation outside the United States. It is our belief that this international crossbreeding of automation information will prove of value.

Soviet Automation

At a recent congress on automatic control in Moscow, the philosophy of the Soviet Union was expressed as follows. "Automation will revolutionize the majority of manufacturing techniques, as it will provide for control of industrial processes which occur at extremely high rates and on a large scale . . . The goals of automation can only be achieved when all steps of the industrial process have been automated in all basic industries, transport, and building, including the assembly, adjustment, inspection, shipment, and distribution of the finished product. . . .

"There is another important problem . . . the study of industrial processes, basic process equipment, and automatic control systems taken as an integral whole. As we believe, it is only this approach that can provide for a qualitative jump in the efficiency of automated installations or plant. It is only this approach that allows all the advantages of automation to be utilized to the utmost. We in the Soviet Union have taken this road."

Another report states that the USSR State Committee for Automation and Engineering has drawn up proposals for the organization of 81 model plants in all branches of the national economy to demonstrate advances in integrated mechanization and automation. At a later date this practice may be extended to 4800 similar plants and factories.

In this same report it states that rotor automatic lines developed by the Soviet Union are considered to be highly promising for automation of technological processes in many fields of production. A rotor machine consists of a drum or a conveyor containing working tools and the mechanisms that set the tools in motion. In such machines the

Circle 685 on Page 19→

ALLEN-BRADLEY

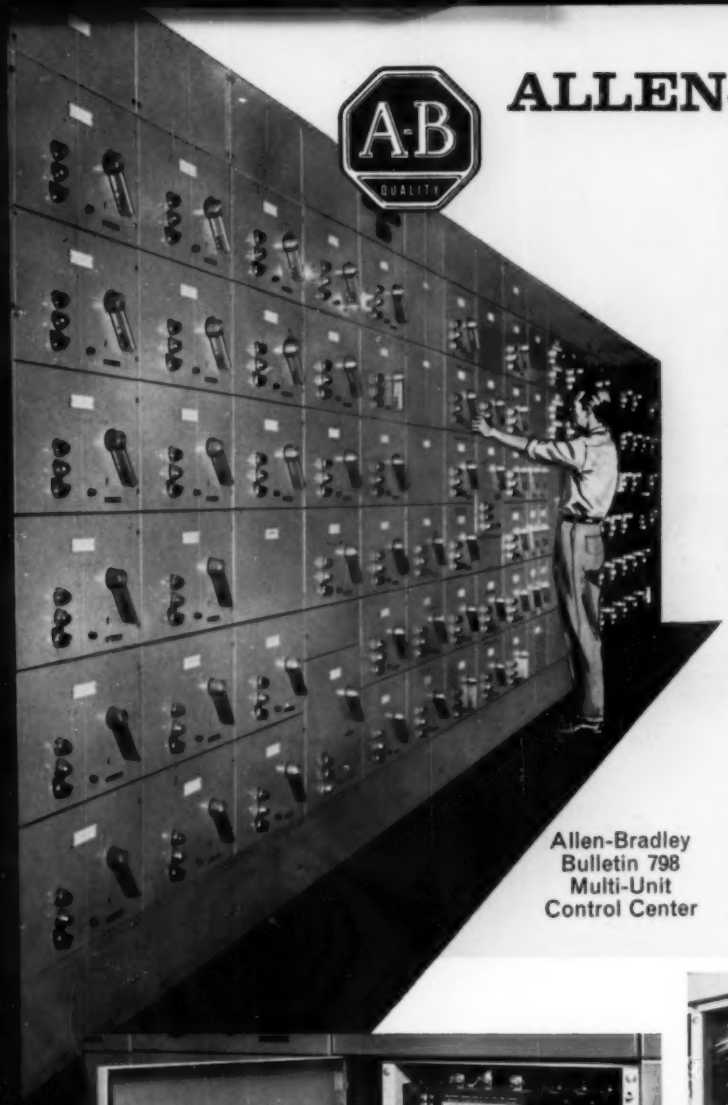
Quality Control Centers

...the mark of a modern plant providing the utmost in reliability, safety, convenience, and lasting beauty

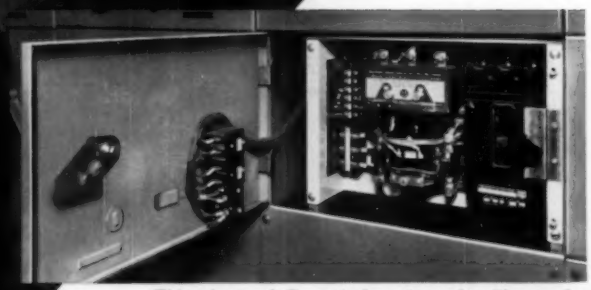
The superior *quality* of Allen-Bradley control centers provides a modern and attractive installation —one that you'll be justly proud to have in your plant. The cost is commensurate with the quality of the workmanship—but you'll never have reason to regret your decision. Furthermore, Allen-Bradley control centers arrive completely wired and tested —and *installed* costs are usually substantially lower than that of individual starters.

The flexibility of A-B control centers makes them readily adaptable to changing needs. Individual units can be added or modified without internal rewiring. In addition, entire sections can be added to meet future plant expansion.

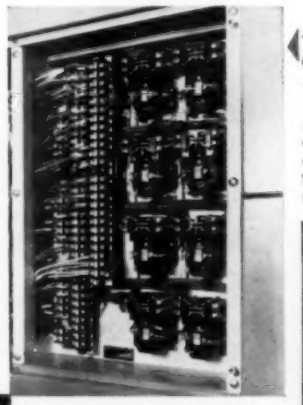
For the finest in control centers, you cannot surpass Allen-Bradley's Bulletin 798. Write today.



Allen-Bradley Bulletin 798 Multi-Unit Control Center

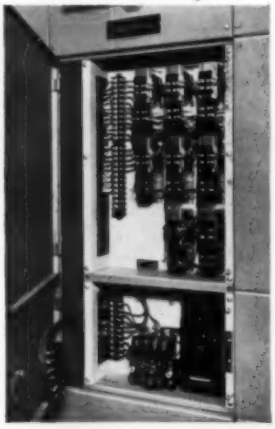


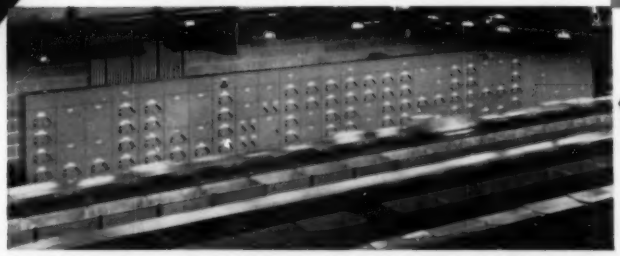
This shows A-B control center unit with popular A-B Bulletin 709 solenoid starter and circuit breaker.



This shows A-B Bulletin 700 control relays mounted in an A-B control center unit.

A-B control centers can be equipped with a wide variety of components. These Bulletin 849 timers are used on an automatic conveyor line.





This huge, 48-foot A-B control center houses 101 A-B Bulletin 709 solenoid motor starters. It is designed to permit an addition containing 50 more Bulletin 709 starters.

ALLEN-BRADLEY

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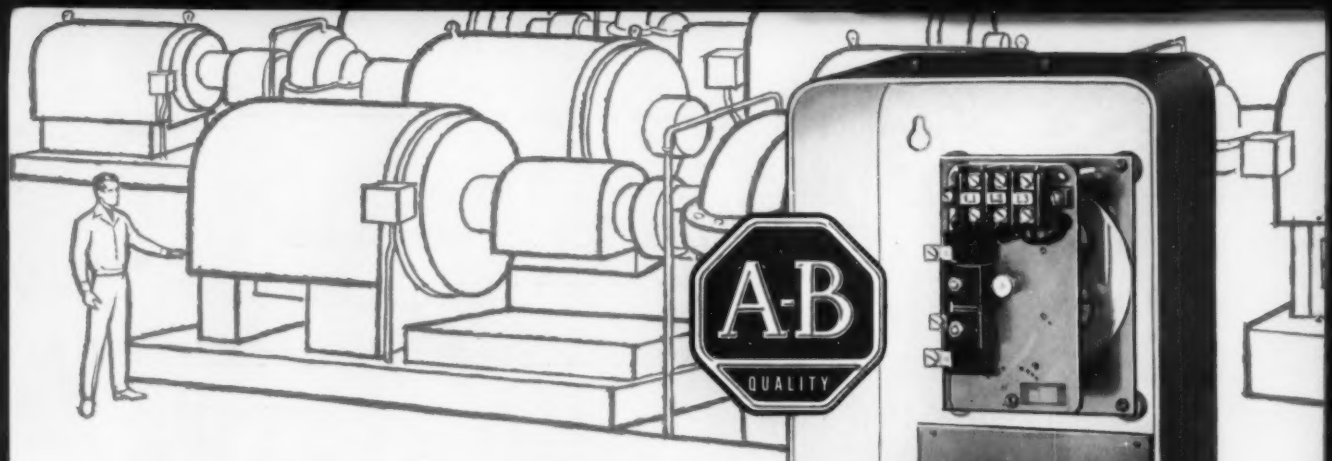
Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. · In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL



ALLEN-BRADLEY PHASE FAILURE *and* PHASE REVERSAL RELAYS

will provide positive protection for high-horsepower, high-priced motors!

It's sound "economy" to guard your investment in expensive motors and equipment against the extensive damage that can result from a phase failure or phase reversal. Allen-Bradley's Bulletin 812 Style RF relay provides *complete, positive* protection against both of these hazards.

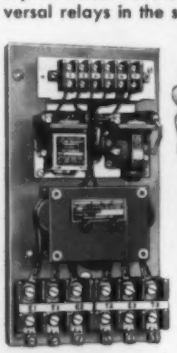
The Bulletin 812 Style F phase failure relay instantly detects *all* open phase conditions on a motor branch circuit and removes the motor from the line—yet is not subject to nuisance dropouts from transient line fluctuations. An unusual feature of this Style F relay is its positive response, regardless of motor load or type of motor branch circuit employed.

The Bulletin 812 Style R phase reversal relay disconnects the motor from the line—whether it is running or not—when a phase reversal occurs on the line side of the relay. Thus, it can be used to protect a single motor or a group of motors. Furthermore, the Style R relay removes the motor from the line should a phase failure occur while the motor is stopped.

All A-B Bulletin 812 relays are completely "fail safe." It will pay you to investigate this economical insurance against the heavy losses that can—and *frequently* do—result from phase failure and phase reversal. Write today!

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Bulletin 812 Style RF for Phase Failure and Phase Reversal consists of Style F Phase Failure and Style R Phase Reversal relays in the same enclosure.



Bulletin 812 Style F for Phase Failure

Bulletin 812 Style R for Phase Reversal

19-60 R

ALLEN-BRADLEY

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Quality Motor Control

articles being processed do not stop at the working tools, but move continually and are processed as they go along.

Several different rotor lines are reported to be functioning in the USSR including machines for the production of parts for sewing machines, radio sets, and electric equipment. The Moscow Regional Economic Council will install 50 automatic rotor lines in the next three years. The Soviet Government has passed a special decision providing for integrated automation of whole branches of industry.

Rome, Italy

Council of the International Federation of Information Processing Societies (IFIPS) elected I. L. Auerbach as its president at a recent meeting. Auerbach is the official U. S. delegate for IFIPS, and represents the AIEE, IRE, and the Association of Computing Machinery. The council, composed of 11 member nations, also met to plan the next International Conference on Information Processing which will be held in West Germany in 1962.

Eastbourne, England

Recent Conference of the Universal Postal Union, held in Eastbourne, included an exhibition of British postal mechanization equipment. Eight firms, combined in an informal association named Manufacturers of British Postal Equipment, offered a complete range of units for segregating, sorting, and distributing mail. A brochure prepared jointly by the member firms, describing the equipment, has been sent to major postal administrations throughout the world.

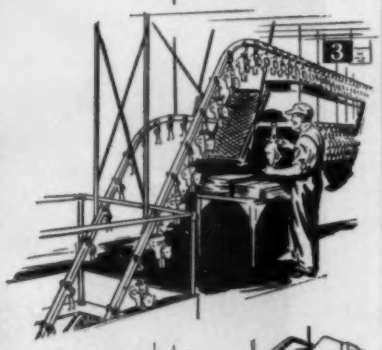
Piacaguera, Brazil

A $22 million contract covering electrical drives, motors, and controls for an integrated steel mill in Piacaguera, has been announced by Westinghouse Electric International Co. Companhia Siderurgica Paulista (COSIPA) is building the mill which will have an initial capacity in 1962 of 600,000 tons of sheets and plates. Westinghouse will furnish electrical equipment for six rolling mills, three process lines, and a blast furnace. Mechanical apparatus for the mill is being supplied by several European manufacturers.

For Cost-Cutting EFFICIENCY in Any Handling Job... Choose BUSCHMAN CONVEYORS

PORTABLES...
Gravity and Powered... Roller, Wheel, Belt

Every practical unit is included in the Buschman widely diversified portable line. Identical couplings both ends permit quick assembly of various types into efficient low-cost combinations.



CABLE...
Overhead, Table, Power-Free

Adaptable to countless operations, they speed production, reduce costs. Universal cable trolley conveyors easily installed from standard, stocked units. Economical, smooth running, durable, efficient.

COMPLETELY ENGINEERED SYSTEMS

Buschman utilizes every type of conveyor necessary in planning individual systems to effect most economical, practical handling of materials. Using Buschman plans and their standard stocked parts, your own men can make installations.

Buschman engineering and equipment encompass the entire conveyor field. Our list of users reads like Who's Who in American Industry! This experience can help you write your earnings statement in larger figures. Tell us your problems; let us send pertinent literature and suggestions. The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio.

Buschman CONVEYORS

Complete Conveyor Systems for all Industries—Engineered, Manufactured, Installed.
Representatives in Principal Cities

884

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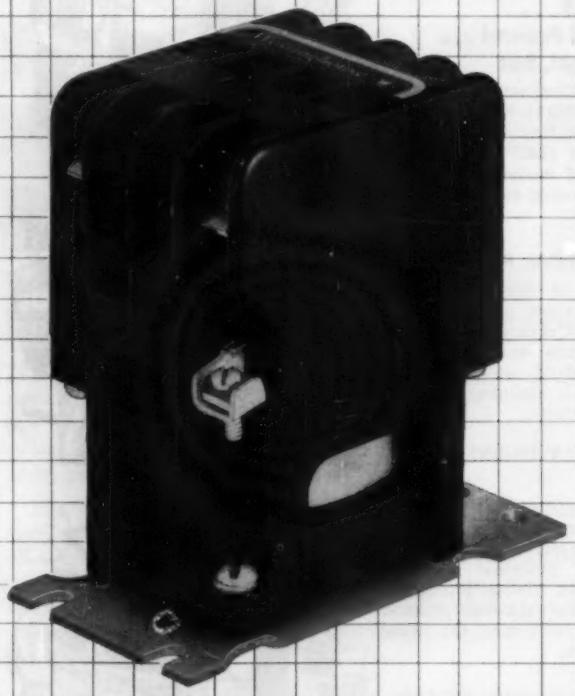
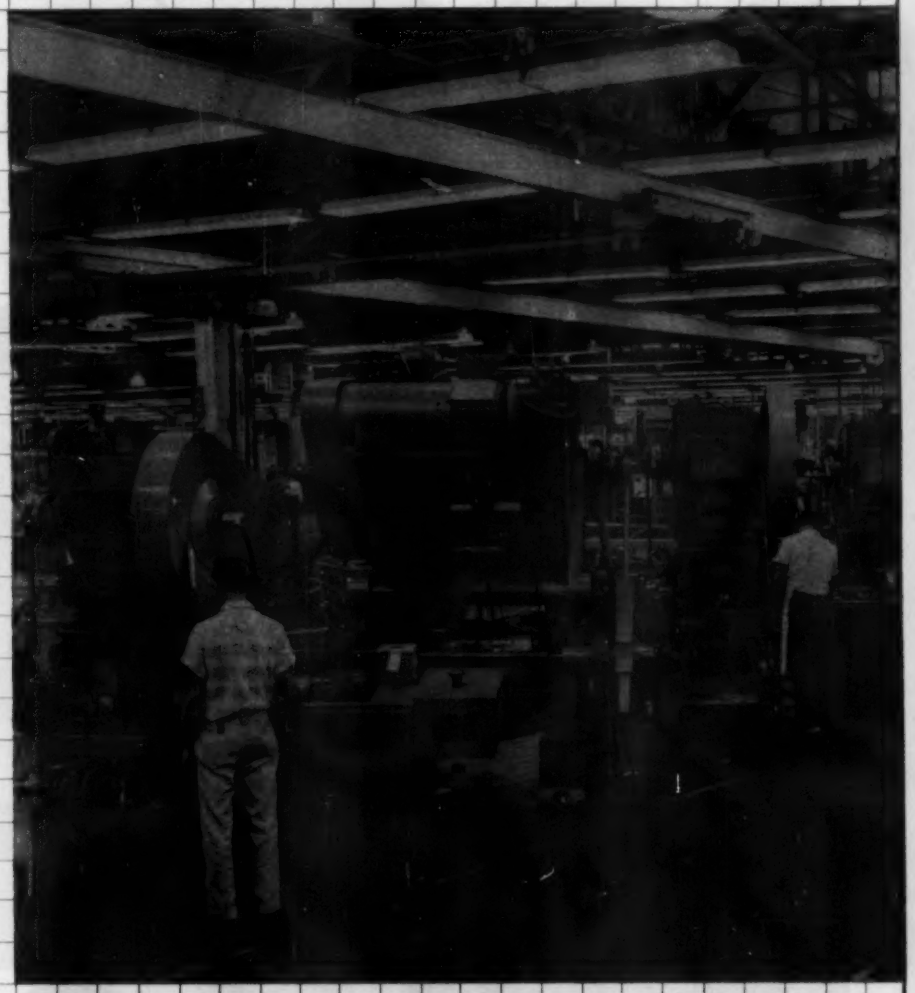
Circle 686 on Page 19



This new Westinghouse BF relay . . .

saves inches here . . .

This new Westinghouse BF relay is small and can be butted one against the other so that your control panels can be reduced in size as much as 50%. Result: valuable plant floor space available for additional machines. Because the relay is specifically designed for automated machine tools, you cut installed costs more than 20%. And since this relay is in stock, you get these savings NOW.



feet here . . .

Want more information on the 5-amp, 300-volt BF and its companion, the 10-amp, 600-volt AF? Contact your nearest Westinghouse representative . . . or write Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. J-30321

You can be sure...if it's **Westinghouse**

Circle 687 on Page 19

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scope of centri-spray

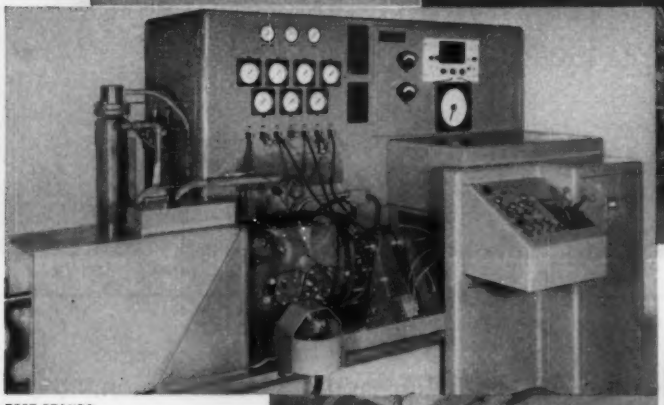
. . . . provides the latitude to fill your automation requirements in production and testing equipment

plus . . . paint spray booths, clarifiers, leak testers . . . hydraulic, pneumatic and electronic test equipment, abrasive cleaning and deburring equipment. Write for details.

SPECIAL MACHINES . . . Automobile-frame piercing and machining line has an output of 120 frames per hour.

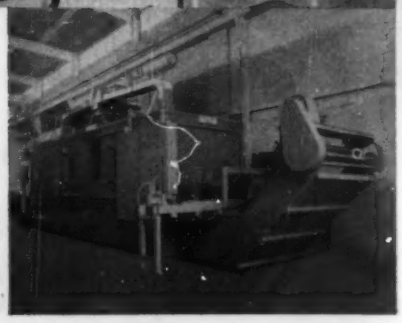
NOT PICTURED

OUR NEWEST . . . CENTRI-BLAST ABRASIVE CLEANING and DEBURRING EQUIPMENT . . . One machine automatically deburrs 250 finished aluminum transmission cases per hour.



MATERIALS HANDLING EQUIPMENT . . . Engine block transfer line set up for test in a Centri-Spray final-assembly bay.

TEST STANDS . . . CEN-TEC dynamometer for precisely checking speed ratio, torque and hydraulic pressure on a 10-speed tractor transmission.



INDUSTRIAL WASHING MACHINES . . . This machine completely washes cylinder heads at rates up to 400 per hour.

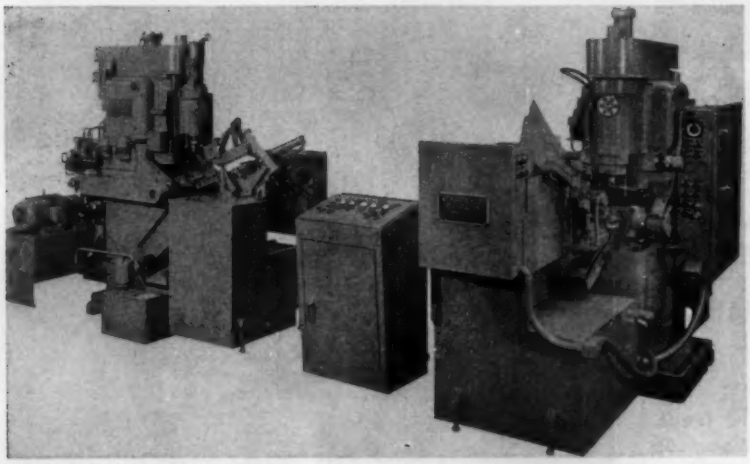
Centri-spray®

CENTRI-SPRAY CORPORATION

39001 SCHOOLCRAFT RD., LIVONIA, MICH.

Circle 688 on Page 19

By JAMES C. KEEBLER Managing Editor



Equipment developed by Micromatic Hone Corp. for two operations of processing truncated spheres of ball studs. Milling machine (right) removes 0.070-inch stock from spherical surface producing 60 microinch rms surface finish and 0.0003-inch sphericity. Microhoning machine (left) employs same fixturing technique, and removes 0.002-inch stock while generating required size, sphericity within 0.0003, and a surface finish of 6 to 10 microinches rms. In production, a spring conveyor assembly transports workpieces between machines. Cycles are automatic.

Spherical Problems

COBO HALL is in the home of autodom and was dedicated in October by staging the 1961 version of the National Automobile Show. Detroit's new exhibition building was described by the show's sponsor, the Automobile Manufacturers' Association as "mammoth."

This is no exaggeration for the facilities provided "Auto Wonderland" in a 104,000 square-foot hall below the big car and truck exhibit. Auto Wonderland was a huge show-within-a-show telling the story of automobile manufacture and the many industries that contribute to the processes. These exhibits were classified by industry groups, with institutional rather than commercial content, and were combined into a show closely integrated by the AMA and the SAE.

Classified by . . .

Categorizing for the purpose of clarifying is one of the big chores of the modern organizer. A *drive* could mean either an automobile component that helps make the wheels go round, or a means of powering the production machinery, or a hit from tee to green, or a roadway to your garage. To those engineers interested in organizing classifications the list of 22 groups chosen for the show is indicative of an approach to the complex maze of the auto industry: 1. Aluminum. 2. Electric Power for Industry. 3. Glass. 4. Iron and Steel Industry. 5. Malleable Iron Castings. 6. Natural Gas. 7. Paints and Protective Finishes. 8. Patents. 9. Petroleum. 10. Plastics. 11. Rubber and Tires. 12. Zinc and Die Casting Materials. 13. Bearings. 14. Body Components. 15. Brakes. 16. Electrical Components and Accessories. 17. Fuel Systems. 18. Lighting. 19. Seating. 20. Steering and Suspension. 21. Transmission and Final Drive. 22. Wheels, Hubs and Drums.

From this list it would appear that the classifiers established headings using criteria such as: What it does, where you get it, what it's made from, and what's consumed in the process. A transmission may include bearings; come complete with iron and steel, malleable iron castings, aluminum, plastics, and petroleum; have parts that are die cast; require both electric power and natural gas to achieve its fabrication; and be covered with patents.

Classified Cross Reference

From this reasoning it could be concluded that all of those groups are interested in gears. In fact it may be that each can be influential in solving a gear problem —depending on the pertinence of the problem to his particular specialty. This further complicates things for the classifier and requires a knowledgeable cross referencer to help the inquirer go away with what he came looking for.

The problem reminds us of the old story that defines a *spherical S.O.B. problem* as one that is an S.O.B. no matter what way you look at it. What is being sought nowadays is the spherical answering technique: no matter what way you approach a problem you end up with the right answer.

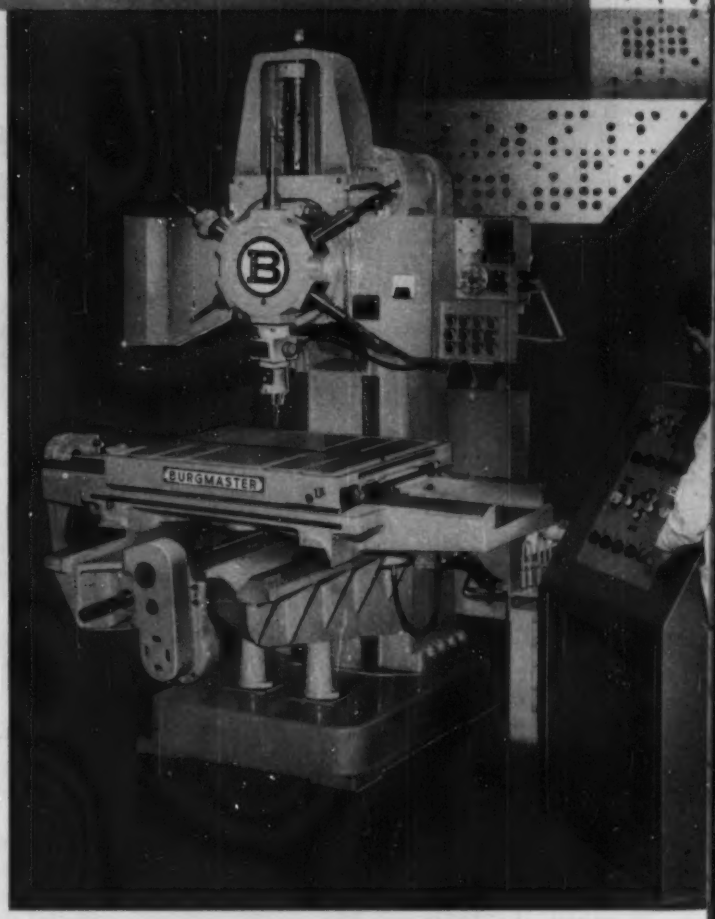
Auto Wonderlanders are not alone in having classification complications. The manufacturing engineers who determine how to make the four-wheeled wonders of 1961 have a few such problems too. Corporate divisions are onetime sliced on the basis of the name on the hood with all responsibilities for a division's cars resting under the division manager. Another time the basis for division becomes component classification with all engines for a corporation's cars coming from the engine division. Type of process is also used as the determining factor with stamping plants making parts for various other plants.

Production Processes

Recently a reader from abroad inquired if any American authors

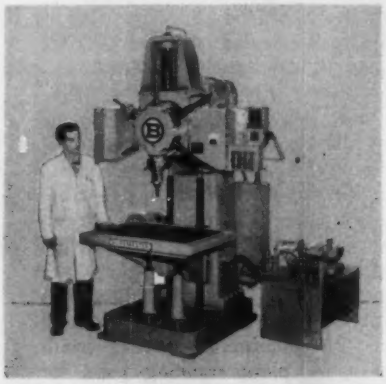
New! BURGMASTER

The new Burgmaster Model 25AHT is a heavy duty tape controlled machine that introduces improved controls and many mechanical refinements. An optional 4-speed motor doubles the spindle speed range; numerical controls of the most advanced design automatically machine complex hole patterns with precision, eliminating complicated fixtures, jigs or drill bushings.



CHECK THESE IMPORTANT MACHINE FEATURES

1. Preselective individual spindle speeds.
2. Speed range: 90-3000 RPM (24 speeds)
3. Preselective infinitely variable hydraulic feeds. — Range 1/4"-50"/Min. Rapid Traverse up and down at 240"/Min.
4. Hydraulic feeds are automatically temperature and pressure compensated.
5. Positive hydraulic feed rates are dial calibrated.
6. Table automatically positions on 2 axis: turret simultaneously indexes through predetermined sequence.
7. Selective rapid approach and return and preset Depth Stops—quick-setting type. ("Z" axis control optional, at extra cost.
8. Heavy-duty construction — weighs up to 10,000 lbs.
9. Quick set-up from one job to another: 25 to 30 minutes.
10. Index accuracy — Spindle to Spindle .0004".
11. Very rigid spindle and turret suspension with turret clamp for programmed milling.

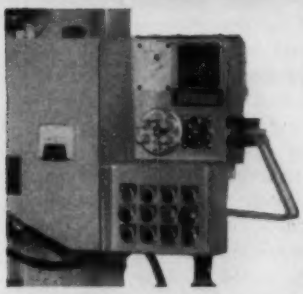


BURGMASTER Model 25AH Automatic Hydraulic 6-Spindle Turret Drilling, Tapping and Boring Machine is also available in this new series and has the same basic machine features and improvements as the model 25AHT Tape Controlled Machine.

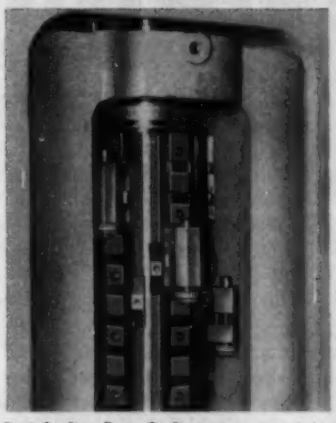
HOW BURGMASTER FEATURES SOLVE TOOLING, PRODUCTION AND INSPECTION PROBLEMS:

- Greatly reduced lead time to get into production—ideal for small lots.
- Simplified tooling—eliminates expensive fixtures—drill bushings not required.
- Easy to program: 1 minute per hole location; prepare tape: 4 holes per minute; set up machine: 3-5 minutes per tool.
- Lower labor costs—requires only semi-skilled labor.
- Less spoilage—does not depend upon operator's skill.
- Greater accuracy of hole location. Table positions automatically ±.001", repeatable to ±.0003".
- Increased tool life—feeds and speeds are preselected for greater efficiency.
- Reduces inspection—center dimensions automatically controlled.
- Easy to operate—one operator can run two or more machines, inspect, deburr, etc.
- Will replace 6 spindle, in-line drills, radial drills, jig borers for many applications, multiple drill and tap heads, expensive fixtures, layout drills, etc.
- Most important—will return its investment more quickly than almost any other standard type machine.

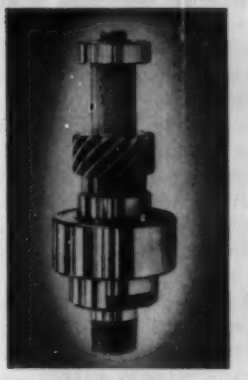
6-SPINDLE TURRET DRILL
AUTOMATIC HYDRAULIC TAPE CONTROLLED 1 1/4" CAPACITY IN STEEL



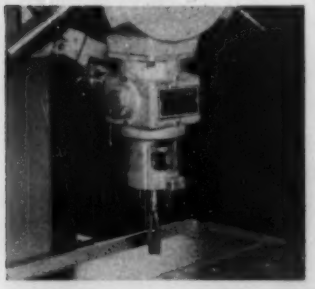
Quick Setting Controls are used to preselect infinitely variable feeds, pressure and temperature compensated, from ¼" to 50" per min., with direct reading dial. Preselect spindle speeds ranging from 90 to 3000 RPM.



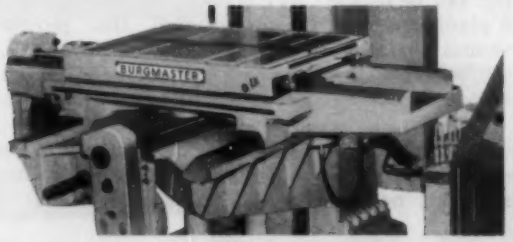
Quick-Set Depth Stops and quick set traverse controls are hand set for rapid set up. Final adjustment with a micrometer screw permits high accuracy.



One-Piece Forged Spindle and Gear provides increased spindle strength and minimum spindle runout. Preloaded high precision double row ball bearing at rear give maximum rigidity.



Lead Screw Tapping Head greatly improves the finish and accuracy of tapped threads and eliminates scrap due to pulled or loose threads. Capacity 1"-8" in steel.



Positioning Table is mounted on a double dovetail column way and supported on double synchronized screw jacks that position table for height. Positioning accuracy in X and Y axes is ± .001" over the table travel, and repeatable to ± .0003".

The Turret is Rigidly Held against the face of the slide on a wear plate and securely clamped in a "V" type cam lock clamping ring to provide increased accuracy during heavy machining operations.

Write for new Bulletin describing Burgmaster Model 25AHT and 25AH 6-Spindle Turret Drilling, Tapping and Boring Machines. Forty-minute 16mm sound film showing all Burgmaster Turret Drills in operation is available without charge.

World's Largest Builder of Turret Drilling Machines

"O" Manual Power Index ¼" Capacity

1C Manual Power Index ⅜" Capacity

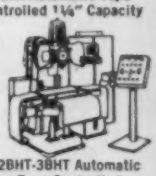
2B Manual Power Index ¾" Capacity

2BR Ram Type Radial Drill ¾" Capacity

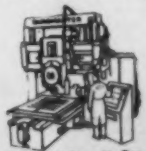
2BH Automatic Hydraulic ¾" Capacity

3BH Automatic Hydraulic 1½" Capacity

25AH Automatic Tape Controlled 1¼" Capacity



2BHT-3BHT Automatic Tape Controlled ¾" and 1½" Capacity



3 BHT-B Automatic Tape Controlled—1¾" CAP.

BURG TOOL

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15001 South Figueroa St., Gardena, Calif.
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have classified production processes by the general shape or configuration of the product to be made. He wants to enter under a sign that says "solid concentric" and learn all about the various techniques for fabricating parts that have a cylindrical external shape. No such published works have been uncovered to date, but the fact that the question was asked can be interpreted as primafacie evidence that the need exists.

The usual classification systems for process information may no longer be adequate for the needs of advanced manufacturing engineers. Instead of doing post graduate work on turning practice, drilling, or grinding, the engineer with production on his mind is more closely oriented to questions such as: How are shafts manufactured? What are the various ways to make this tubular part? How can we make a sphere?

Making Spheres

As a case in point, a look at all sides of the problem of making spheres would be as informative as it is extensive. They can be blown in glass, molded in plastic and rubber, diecast in various materials, forged in steel, cast in iron, and turned in almost anything machineable.

Automakers are interested in this spherical problem because of the growing use of ball-joints on the modern auto. In addition to the geometrical sphere (ball) there are variations on the theme that involve spherical surfaces mounted on shafts (sphere-on-a-stick). These include uses as ball valves, rod ends, and ball studs. This latter is a vital component in the ball joint front suspension system which provides an ideal means of combining suspension and steering motion into one package.

Ball Stud Processes

The sphericity problem associated with the manufacture of ball studs has been described as that of generating a truncated sphere. The sphere is complete with the exception of a tapered, threaded shank that protrudes from it. Generally the workpiece is a forging that is subsequently machined, hardened, ground, and buffed. By locating or chucking the workpiece on the tapered shank the machining of the sphere can be accomplished by using either form tools or single point turning with special provisions to trace a circular path. Grinding requires formed wheels.

Engineers at Micromatic Hone Corp. studied this process and listed some of its drawbacks. Accurate roundness is difficult to achieve without controlled stock removal and the presentation of the surface to be machined to the cutting tool at a relatively consistent rate. The result is that turned parts have tolerance troubles and so do ground ones. Although buffing can obtain the required surface finish, it does nothing to correct geometric errors.

A new technique and two special machines developed by Micromatic have reduced the processing (from the heat-treated forging state) to consist of the operations of spherical milling and Microhoning.

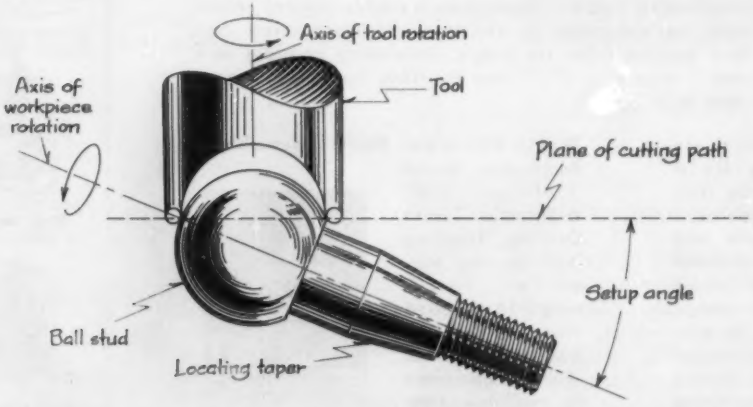
The process can be applied to any truncated external spherical surface so long as there is some means of holding the part without touching the spherical portion, and the heat treatment leaves the part in a machinable state.

First operation on the spherical surface is called milling and apparently takes this name because the cutter resembles a hollow mill, and rotates about its axis. However, the machine has certain aspects of a lathe in that the workpiece is chucked and rotates about its axis. The regular machine tool classification system is not descriptive in this case, and so far as the process is concerned, it is probably more appropriate to call this a *machining* machine than anything else.

From the manufacturing engineering point of view the problem is to produce near-finished size and geometry. Whether this is called milling or turning is incidental. This is a spherical problem and the name of the machining technique neither improves nor detracts from its value as a production process.

The second step in the new process is called Microhoning and is that company's tradename for their equipment that uses low-velocity abrading techniques with area contact between the work surface and abrasive. The machine works on the same principle as the other. However, an abrasive cup is substituted for the milling cutter. This operation not only produces the required 6-10 microinch rms surface finish but also generates correct geometric shape such that final sphericity is within 0.0003-inch.

These machines are equipped with automatic loading and unloading devices and automatic control systems. Automatic transfer from the milling machine to the loader of the Microhoning machine provides a high degree of automated production for spherical problems.



Disc insert cutting tools are held in place by clamps in hollow-mill type tool. Ball stud is located on taper and clamped on thread. Fixturing positions part at setup angle such that plane of cutting path intersects centerline of ball at crown and intersection of shoulder and sphere. Circular path of rotating cutter is used to generate sphercial surface by rotation of workpiece. Geometry of arrangement permits every point on sphere to be machined at near same surface speed.

Circle 690 on Page 19→

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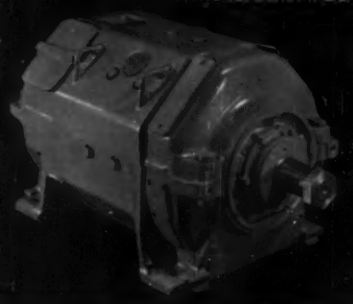

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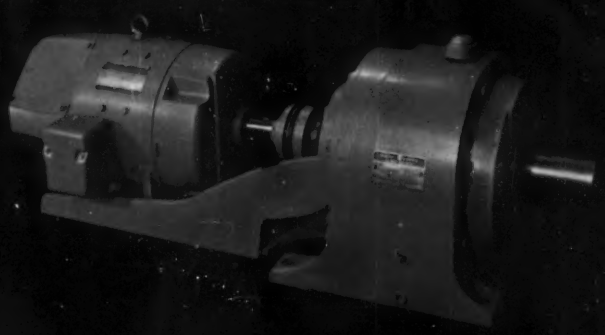


Competence or Policy

Management executives in most companies recognize the value of suitable investment in the future of the enterprise where new or improved products are concerned. The proximity and involvement is so direct that the question is not one of should new product research and development be undertaken but rather what appears to be the most promising path to follow.

The case is different where research and development in new production methods and machinery is involved. Here, rather than finding executive decision in terms of future corporate profits, the problem is often relegated to manufacturing managers as a cut-and-dried procedure from which specific returns must be guaranteed. This procedure, at best, is somewhat unrealistic and often results in manufacturing costs far higher than necessary.

Specific and guaranteed investment returns are extremely difficult, if not impossible, to document accurately unless methods or machines are either old or have been fully researched. The result is that new opportunities are far too often passed by, since few managers can afford the gamble. If product development were approached on the same basis, new products would seldom see the light of day.

Tomorrow's most profitable manufacturing innovations will result from today's well-planned manufacturing development work. In the process of creating the radically new approaches needed, there is no question that a few "dry wells" will have to be drilled. But, where little is risked, little will be gained.

Are you providing your manufacuring and process engineering teams with the key tools for insuring profitable operations? An adequate manufacturing research and development program will create the best bulwark against the competition ahead, but it requires a sympathetic appreciation of the risks and difficulties involved.

Manufacturing capability needed for successful competition in the sixties unquestionably will call for a rising level of technical competence. More significant, however, will be management's overriding influence stemming from basic policy on development and exploitation of new methods.

PUBLISHER-EDITOR

. . . The goal throughout the proposal stage is realism. A poor decision can be caused just as quickly by the so-called conservative proposals as by the too optimistic one . . .

PROCESS ANALYSIS AND MACHINE PROCUREMENT

What are the significant steps required in process analysis for automation? What are the basic considerations in procuring suitable equipment to accomplish the ends desired?

By **HENRY A. LEONE**, Manager, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., Pittsburgh, Pa.

IN THE BROAD sense, lowering the cost of manufacturing operations by applying advanced automatic methods and equipment raises the question not of "whether?" but of "to what degree?". The number of factors which must be considered in answering this question, and the variety of conditions under which they may apply, prevents setting up any all-inclusive formula which will give a complete and final answer. Rather, experience and judgment must be applied to many intangibles and combined with a thorough analysis of the tangible factors to reach a sound decision. A cost analysis is indispensable, but it is not infallible.

Four aspects of a proposed change must be favorable to make an investment a good risk: The product, the equipment, the results, and the future. The product must be ready; the equipment must be practical; the results must be real; and the change must fit into future plans.

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

It is possible for a situation to develop occasioning a poor risk project to be given the green light. This may happen when the reduction of costs promised by the proposed automatic production is essential to survival of the product in a highly competitive market situation. In a situation like this, corporate management may be willing to gamble on a project that is technically speculative. But manufacturing management, by itself, must not gamble; and it certainly is the responsibility of manufacturing management to avoid circumstances necessitating corporate management to pass judgment on a risky venture.

▶ Is the Product Ready?

The characteristics of the product to be made can easily determine the success or failure of an equipment project. There must first of all be a continuing need for the product. Studies of market potential must be projected to the time when the new

facilities will be in production. If the future need of the product is assured, what changes can be expected?

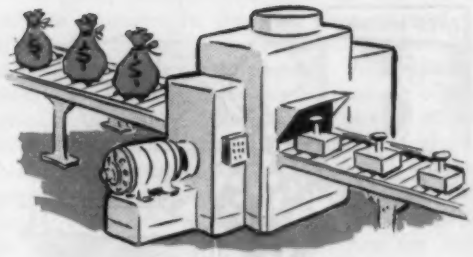
A real effort must be made to anticipate not only planned changes but changes that may be forced by competitors. Under the best of conditions, improvement is a necessity vital to survival of the product line and must be provided for in new equipment plans. On the other hand, many products are subject to frequent model changes and only off-the-shelf production equipment is practical. Standardization of product subassemblies can provide activity stability needed for automation in these cases. Various combinations of subassemblies can be used to produce a complete product line, and changes in details and accessories provide the possibility of yearly changes without requiring the scrapping of the basic production equipment.

Has the product been verified and made in sufficient quantity to prove it operable and free from major service trouble? Has it been proved producible without hard-to-control manufacturing operations? The combination of a new product and new automatic equipment can lead to disastrous development costs. A few years ago, when the production of transistors was in its infancy, a completely automatic production line was being proposed. Fortunately, before any real money had been spent on equipment development, it was possible to convince the proponents of this scheme that the time was not ripe for automatic production of the product. Besides not really knowing how to make this product, the industry was faced with countless new types, sizes, and configurations, as is typical of so new a product.

Another frequent trap is the quality and uniformity of the raw material and purchased parts going into a product. Automatic equipment puts far more stringent requirements on this factor than a manually supervised operation. The least suspected items, such as screws, nuts, and other standard hardware, are often the worst offenders. Many things can be done to correct this situation—working with suppliers, substitution of closer tolerance material (such as cold rolled steel for hot rolled), and even 100 per cent incoming inspection or presorting—but all of these cost money and must be considered in the cost analysis of the proposal. Discovery of such needs after the machine is built can drastically reduce the expected returns.

TABLE 1—Key Questions in Analysis of Proposed Automation Projects

The Product	The Equipment
Is there a continuing need?	Will it work?
Is it proved?	Will it be reliable?
Will it change?	Is flexibility adequate?
Is material uniform?	Are operators used wisely?
The Results	**The Future**
Have alternatives been evaluated?	Are long-range plans satisfied?
Are project costs realistic?	Is this step big enough?
Are expected savings real?	Should a smaller step be made?
Have intangibles been considered?	Are other business policies affected?



. . . The combination of a new product and new automatic equipment can lead to disastrous development costs. . . .

▶ Is the Equipment Practical?

Product questions can be answered before any detailed planning of production equipment is started. During the proposal stage the same broad type of questioning must be applied to the equipment. Taken together these questions add up to the single question, "Will it be practical?".

It may seem obvious to say that the equipment must work. Yet many projects have failed simply because the equipment did not work. This is usually due to confusion between a development project, where some doubt of workability must exist, and a proposal to furnish equipment that will produce so many pieces per hour on a certain date. The latter must be composed entirely of proved devices and methods if the cost analysis is to be taken at face value. A combined project should always be planned in two stages, with no doubt left in anyone's mind that the ground rules are different in each stage.

The question of reliability comes after it has been established that a device will work. This question involves more than just the individual performance of elements; it is concerned with the time that the system as a whole operates. As the number of continuous machine functions goes up, the demand on component reliability goes up since (within the limits of practical reliability) the downtime effect of the individual components on the system is additive. There are three approaches to improving reliability:

First, each of the components must be made as reliable as possible. In controls, for instance, the use of static elements has improved reliability over electromechanical types. The reputation of the supplier is an important index to the reliability of the component. Above all, the supplier should be chosen who has experience in the particular type of opera-

. . . experience and judgment must be applied to many intangibles and combined with a thorough analysis of the tangible factors to reach a sound decision.

tion to be performed. All of these things reduce the number of failures.

The second approach is to limit the downtime for each failure. This means plug-in units, trouble-shooting aids, quick release, and overload mechanisms, etc. The existence of a well trained, fast acting maintenance crew is a must for getting a line back into operation quickly.

Third, but most important, the number of operations in a continuous interdependent sequence must be limited to the number dictated by the reliability of the component units. In other words, systems can be made inherently reliable enough to make up for deficiencies in the individual machines. For example, it may be economical to provide duplicate capacity on sensitive operations with provision for alternate use in case of breakdown. This raises the system reliability.

Flexibility has become a key word in connection with automation at Westinghouse. Mechanized equipment is frequently built with provisions for adjustments that allow working on a family of similar parts, but the real savior of automation for the low activity manufacturer is numerical control. As this equipment becomes more reliable and programming techniques become streamlined, more and more similar operations on completely dissimilar parts are becoming practical, even down to lot sizes of one piece. While a machine to do anything to anything has not yet been practical, some of the newer numerically controlled machines are coming pretty close.

Experience with numerical control of test equipment at Westinghouse has been especially good. Tape programmed electrical testing has made possible products for which manual methods would have been prohibitively expensive. Adequate flexibility should be the goal. Excess flexibility invariably increases complexity, and this tends to reduce reliability.

Effective use of operators should be investigated. The capacity for complex mental and physical actions by an operator can not be approached by the most sophisticated equipment; it is only when the task can be simplified and completely defined that the machine can compete economically with man. As an example, most of the highly successful automatic assembly machines used by the Delco-Remy Div. of General Motors retain some tasks to be performed by operators.

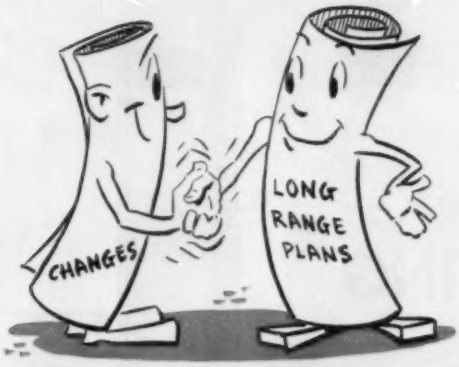
In some cases the machine is a temporary unit to be replaced later as activity or development time warrants; in other cases, it is the best permanent solution. Automatic part feeders are an example of equipment that can fail in an enormous number of different and unpredictable ways. A relatively simple feeder, or group of feeders supervised by an operator, can be more reliable and far less expensive than its fully automatic equivalent.

Good motion study practice is important on mechanized equipment as well as in manual operations. If an operator is required on a machine at all, then his time should be efficiently utilized. An expensive, even though practical, machine element may be eliminated if the operator can perform its function, too. However, the total equipment cost on automatic equipment is usually higher than the labor cost; so, the machine utilization is still the most important. Total operator time with allowances must be kept within the machine cycle time to be sure the machine sets the pace.

▶ Expected Results

After a cost analysis of the proposed project has been made, it must be examined to be sure it is realistic and is the best alternative. A project is good or bad only by comparison with alternatives. One of the alternatives should be the best possible manual method, not necessarily the method in use. Again be realistic; there are circumstances where the most economical manual method may not be possible to achieve from an industrial relations standpoint. The mechanization may then produce worthwhile savings even though it is not the best theoretical solution. Be sure that full benefit is taken of the experience of any other divisions and plants within your company. Also, benefit by the successes

. . . Compared to equipment costs, savings are difficult to estimate. In the first place, present costs chargeable to the particular operations being considered are difficult to pinpoint. . . .



. . . the change being made must be compatible with long range plans. The forecasted results aren't likely to be realized if engineering, sales, or corporate management has plans that will prohibit the equipment's continued utilization. . . .

and failures of your competitors in their progress toward higher mechanization.

The incremental value of each part of the proposal should be studied since most of the proposed improvements might be made at a fraction of the total proposed cost. There is a serious pitfall to be avoided here though. Consideration must be given to the future actions of competitors and the possible effects on selling price. The total cost level must be considered as well as savings over present costs. An anticipated large return on a small investment may be wiped out completely by an early price reduction forced by competitive action. On the other hand, a study might show that a large investment with a low rate of return will realize a satisfactory profit after a price reduction because the absolute level of cost would be lower.

When assessing the realism of the proposal, both the costs and the savings should be examined closely. Are prices firm or estimated? If firm, is the supplier experienced enough to quote realistically? His responsibility to meet a price does not deliver the equipment, and delays can cost more than the difference between quotations. Serious errors are more apt to arise from leaving something out of the proposal than from missing an estimate.

Debugging, though often underestimated, is usually included. However, factory familiarization costs can postpone savings up to a year or more on large projects. It may be impossible or impractical to maintain production on existent equipment during installation and tryout of the new. But, if this is anticipated, installation can possibly be scheduled for a period of high inventory level.

Rearrangement of existing facilities, special aspects of space preparation, unusual shipping costs—all of these are items that are apt to be included as percentage figures from past experience. They may be far out of line for the more drastic type of change being proposed. Parts of the machine itself—for instance, preinspection and presorting devices—may be overlooked if they are not part of the primary function.

Compared to equipment costs, savings are difficult to estimate. In the first place, present costs chargeable to the particular operations being considered are difficult to pinpoint. Accounting systems are not designed for this purpose. One guiding principle should be followed. The savings figure in every case should represent changes in actual dollars being spent rather than changes in any particular portion of an accounting statement. The second difficulty arises from the fact that operating conditions in the future must be assumed. Are the savings heavily influenced by the assumed conditions? If so, the validity of the assumption must be looked at very closely. How long will the facility actually be used? Will it operate more than one shift? What will your competitors do? In some cases the proposal may have to be worked up for several different answers to these questions.

The preceding considerations are not intangibles; they are simply uncertainties. The intangibles are questions like: Will employee attitudes be changed by the introduction of this equipment, possibly affecting other operations? Is the need for improvement recognized by those who must make the machine operate profitably? Will the improved quality sell more product?

The goal throughout the proposal stage is realism. A poor decision can be caused just as quickly by the so-called conservative proposal as by the too optimistic one.

▶ The Future

As a final consideration, the change being made must be compatible with long range plans. The forecasted results aren't likely to be realized if engineering, sales, or corporate management has plans that will prohibit the equipment's continued utilization. It is advisable to ask: Will we stay with this product line? If the plant is an old one and costly to maintain, be sure the company intends to remain in it long enough for the proposed project to be worthwhile.

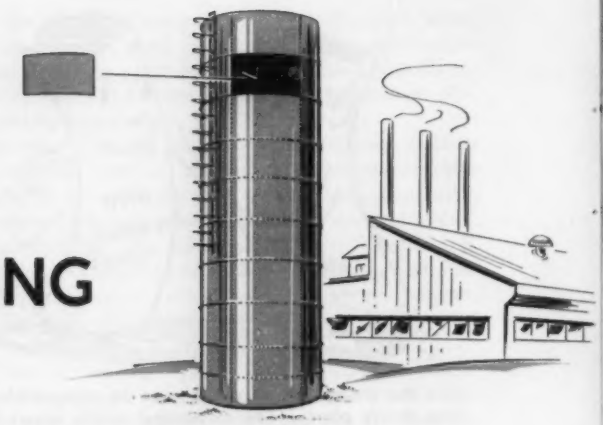
Clarify the situation relative to available funds for equipment acquisition. The problem could take on great magnitude if, due to limited capital or engineering time, the adoption of a proposed project were at the sacrifice of numerous lesser proposals that would aggregate a greater saving.

A modest first step is fine to establish principles and get a quick return, but it may jeopardize the possibility of later improvement if not carefully planned. Where manual operations are left in, adequate space should be provided for later mechanization. Future improvements should add on rather than replace wherever possible.

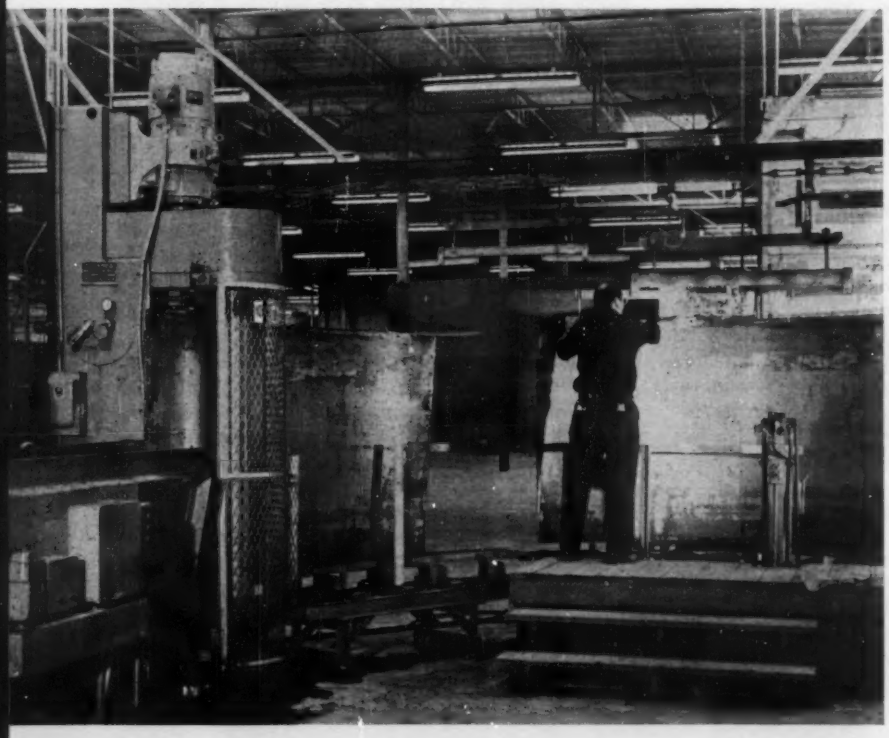
Numerical control is an example of providing for future benefits when properly planned. While it may be used today for machining, the components can fit into a system tomorrow to handle production, test, and even design requirements. The day of the completely automatic factory may be a long way off for most of us, but each improvement taken can be a step along the road to that goal.

AUTOMATION TODAY

COATING STEEL WITH GLASS

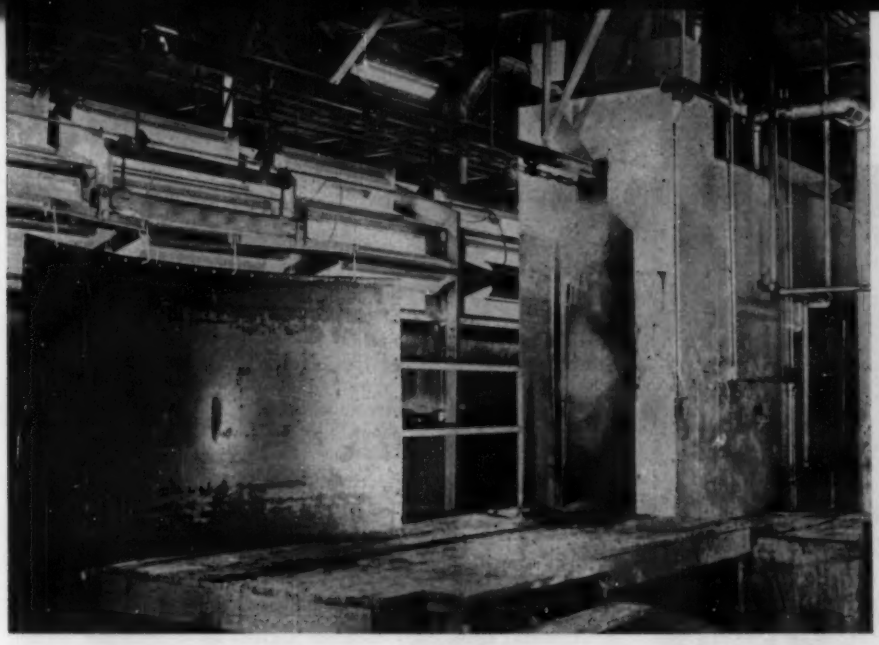


ONE of the technical facts of life—and an important economic fact—is that the typical ferrous product can corrode to the point of uselessness unless protected by some means. A variety of techniques are employed to obtain the desired protection: The base metal can be coated with other metals, such as zinc; the surface can be treated or converted, as in obtaining a gun-metal finish; or the surface can be covered with an inorganic or organic coating, as in painting. Applying a vitreous coating—in which a glassy composition is actually fused to the base metal—can be thought of as a



1

Cylindrical shaped storage structures are fabricated from formed steel sheets. Shown in one of the early stages of processing, 5 by 9 foot sheets are formed with an 8½ foot true radius as each sheet passes through two pinch rollers and is drawn past a wedge-shaped shoe. Prior to this forming operation, each sheet has been mechanically cleaned, has had 70 holes punched around its outer edges, and has been oiled. Following the roll forming operation, each sheet is attached to an overhead conveyor by an operator, as illustrated.



2

Overhead conveyor from roll forming operation passes through washer. Surface preparation is critical to effectiveness of fusion process which occurs at later point in line. In the washer, sheets are washed using 200F caustic hot water. Each sheet is subjected to two washing cycles plus 180F water rinse, remaining in the washer for a total period of 4 to 5 minutes.

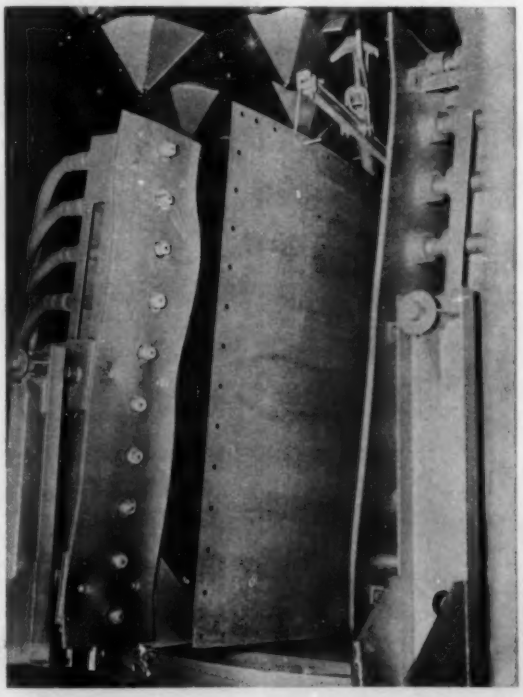
special form of the latter technique.

Vitreous coated, or glass lined, commercial equipment is in common use with perhaps the best known applications being found in the chemical and food industries. An application area of increasing importance and size involves silo-style bulk storage structures. The same factors which make such structures an attractive investment for storing grain products have recommended their use in industry. For example, in addition to grain products and their derivatives, other bulk materials which have been stored include such items as dried citrus pulp, meat byproducts, sugar, coffee beans, sawdust, wood pulp, cork, various plastic pellets, granulated asphalt, ground rubber, and tobacco.

Reflecting the growth of the market for these storage structures, Harvestore Products Div., A. O. Smith Corp., has established a new plant at Kankakee, Ill. The plant is devoted to the production of Permaglas industrial bulk materials handling systems and Harvestore mechanized feeding and processing equipment. The facilities include a glass milling room where glass "frit", along with added silica, clay, bentonite, borax, and water, are placed into mills consisting of porcelain lined drums. Each mill contains 4 tons of porcelain balls which, with rotation of the drum, reduce the materials to "slip." Subsequently, the slip is held in storage tanks, being pumped to the spraying area as needed.

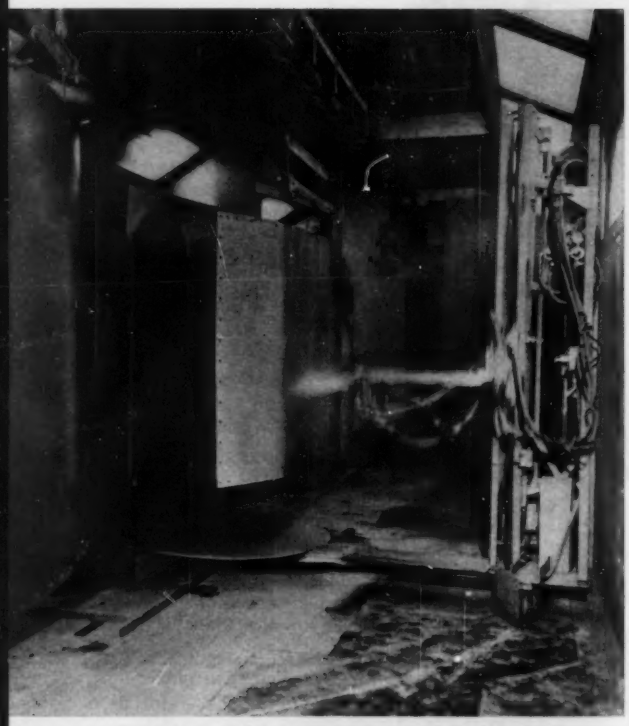
When placed on a prepared steel surface and fired at a low-red to bright-red heat, the slip becomes a smooth, impervious coating that is fused to the steel. Although the coating is glass, it adheres to the metal and resists punishment, both by impact and by rapid changes of temperature.

One of the principal units of production in the



3

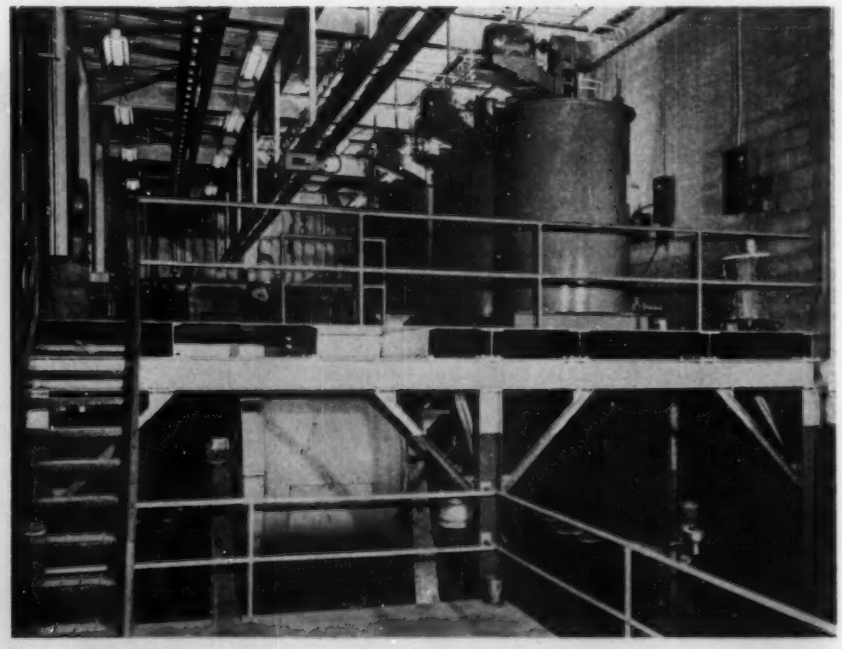
Still attached to overhead conveyor, sheets are passed between two banks of 10 nozzles from which steel-grit is blasted. Purpose of this etching operation is to roughen surface of both sides of the sheet preparatory to receiving a coating of slip. Glass coating differs from other types of coating in that the glass is actually fused to the base metal.



4

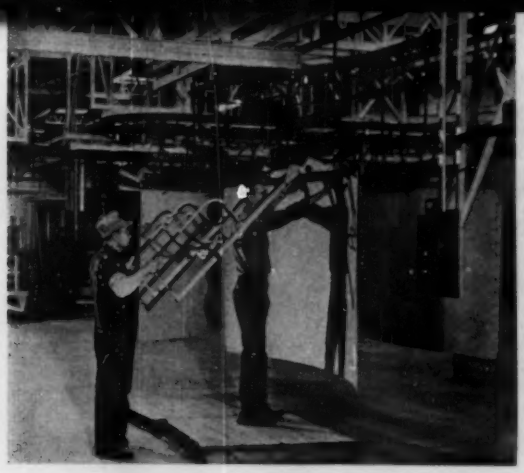
In spray booth, slip is automatically applied to both sides of the formed and prepared steel sheets. In illustration, convex side of sheet is receiving a coating of slip. Spray nozzle mechanism is mounted on wheeled assembly. As nozzle mechanism cycles the spray nozzle in the vertical plane, the wheeled assembly moves about a pivot point in the horizontal plane resulting in a spray pattern that follows the circular arc contour of the hanging sheet.

plant is 5 by 9-foot steel sheet, ranging in thickness from 3/32 to 3/16 inch. These steel sheets are mechanically cleaned, edge pierced, rolled into circular arc form, chemically cleaned, etched by a steel-grit blaster, coated with slip, dried, and subsequently passed through a fusing furnace. At the completion of the processing cycle the sheet is a curved glass-coated module ready for assembly into a silo-shaped storage structure. The pictures accompanying this article highlight the handling aspects of sheet processing.



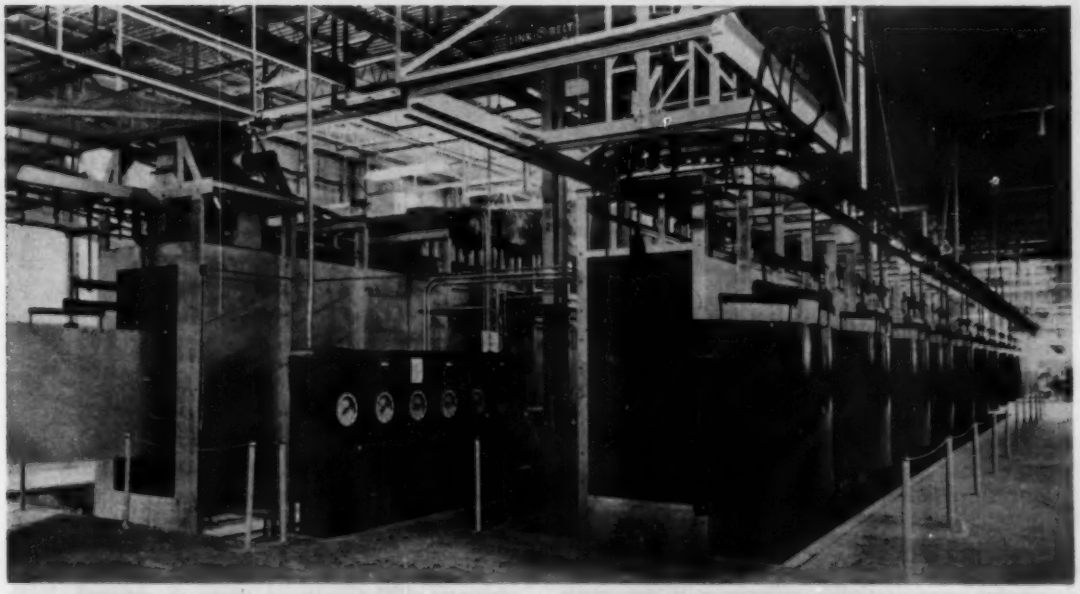
5

Slip is supplied to the spray areas from this mill room. On the lower level of the mill room are located two ball mills—each mill is a porcelain-lined drum containing 4 tons of porcelain balls. Glass frit and other materials are placed in the mills and processed into slip. The slip is stored in tanks on the upper level of the mill room. The slip is continuously agitated in the tanks and circulated through lines which are tapped in the spray area, providing a uniform mixture of slip at the spray nozzles.



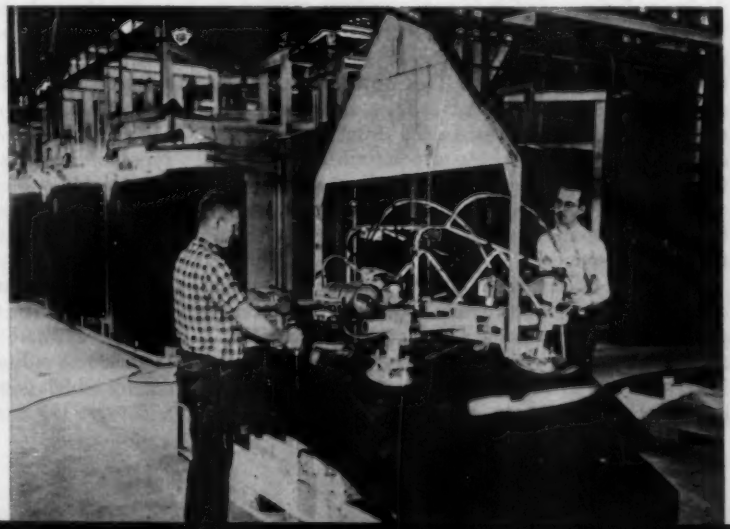
6

Freshly coated sheets are conveyed from the spray booth to a drying oven for a 10 minute long drying cycle. Following the drying operation, sheets are manually transferred from the overhead conveyor on which they have been traveling to either a storage conveyor line or to a conveyor line leading to the furnace. For optimum operating conditions, the furnace line must be kept supplied with sheets. In the event that sufficient sheets are not provided directly from the spraying operation, furnace requirements are met by transferring sheets from the storage line. Furnace indexes forward in definite stop-start pattern, enabling sheets to be manually transferred between conveyors.



7

Gas fired, radiant-tube furnace in which slip is vitrified is U-shaped and contains three heating and three cooling zones. At left, sheet is shown entering furnace. Finished glass-lined sheets are emerging from furnace at right. Sheets are fired at temperatures as high as 1520F, and emerge from furnace at a temperature of approximately 100F.



8

Sheets are inspected at the completion of the firing operation. Acceptable production is stacked on special skids as shown. Rejected sheets are returned to the production line for repair or reblasting to bare the plate for a new coat of slip. The specially designed handling fixture contains suction cups, enabling a sheet to be held, lifted off the conveyor, and stacked with a minimum of effort.

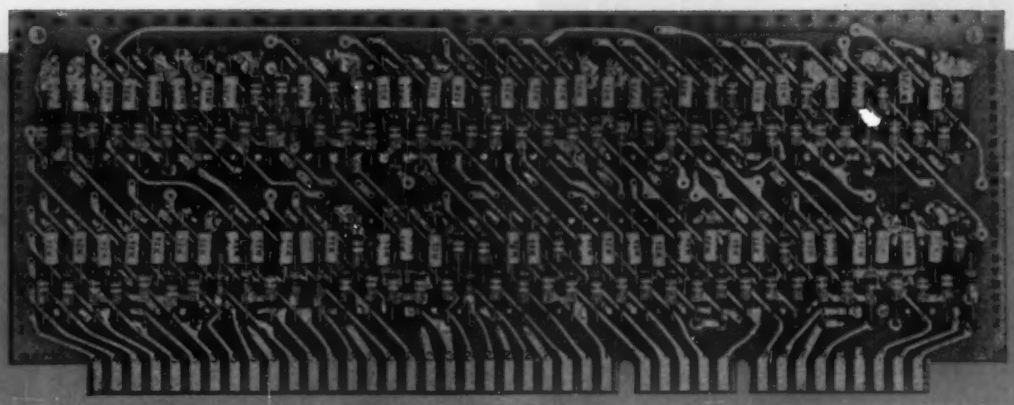


Fig. 1—Illustration suggests the complexity found in some modular components and the difficulties encountered in testing such modules. This particular board required 270 functional tests before it could be certified as an acceptable component in an airborne digital computer.

TESTING SUBASSEMBLIES

By **MARTIN RUBIN,** Data Systems Project Engineer, Autonetics, Div., North American Aviation Inc., Downey, Calif.

DEMANDS for increased performance have fostered the development of new concepts and techniques in both the design and manufacture of electronic components and systems. One of the developing manufacturing techniques is automatic testing of individual subassemblies—an important phase in the production process if reliable end equipment is to be obtained at reasonable costs.

It is interesting to note how the development of an automatic manufacturing technique, such as testing, is so closely related to developments in design. For example, modularization is now a well established design technique, and it is now standard practice to build up complex systems out of small electronic subassemblies, or modules, which can be plugged into a socket or connector. This approach contrasts sharply with techniques of only a few years ago when equipment was assembled from components connected together by point-to-point wiring, the only truly removable devices being vacuum tubes. It is the expanding use of the module technique that has made automatic testing of subassemblies both feasible and practical.

A module is characterized by extensive use of etched circuits, extensive use of subminiature components, high component density, and electrical access through connectors. These characteristics are illustrated by *Fig.* 1. The module is one of 30 logic boards contained in an airborne digital computer. Consideration of the test requirements for this board also illustrates why manufacturers have turned to automatic testing. To certify that this particular board is acceptable for use in final assembly of the computer, 270 functional tests are required. With manual testing, the procedure consisted of: Reading the test instructions, setting switches and controls on instruments, probing the circuit board, reading the appropriate test meter, and recording the test results.

As an average, these operations required 1.5 minutes to perform. Almost 7 hours would be required to run through the functional tests of a single board. When recycle times for repair and retest of faulty modules were included, each board accumulated almost 10 hours of test time. To maintain the necessary production rate, 12 manual test stations were required. This is but one case. When all the various types of modules in the particular computer were considered, it was found that each module required at least one test station and that each took from 1 to 10 hours to process.

These figures are not too surprising since subminiaturization and high component density are deliberately chosen to obtain as many functions as possible in a small volume. The engineer has reacted to stringent military electronics requirements by producing a high density subassembly to conserve weight and area. For ease of maintenance it is designed as

More and more the electronics industry is turning to the use of module boards. Testing these subassemblies can be a sizable problem: Relatively small production quantities of a given type of board are the rule and test requirements are exacting, changing for each type of board. Solutions to this production problem are highlighted in this article.

Fig. 2—Testing jig containing precisely located probes is illustrated. Use of such testing aids can speed up testing of miniaturized modules which must be probed at a variety of locations during a test cycle.

a plug-in, sometimes potted or sealed for reliability. The factory has reacted to the stress of fabricating these devices by resorting to automatic testing techniques.

▶ General Considerations

Automatic module testing starts on the drawing board. The first consideration is function. A catch-all circuit design in which the module is a package of circuits without relationship will require a catch-all of test equipment. Unitization of function is of utmost importance. A 3.5 by 4.5-inch circuit board can easily accommodate four flip-flop assemblies, or two regulated dc power supplies, or a multiple of gates and logic networks. Packaging by function creates a module more universal in application and makes for economic automatic test equipment.

Access is also of prime importance. The test points must be readily accessible and provide good electrical contact. Connectors provide the most reliable means of tying into the module under test. If access to the surface of a circuit board is required, test jacks or plated-through holes must be precisely located to accommodate the probes.

An iron-maiden type of probe jig is seen in *Fig.* 2. Here the required number of test points were so numerous as to prohibit the use of connectors. Surface access is achieved by building a jig in which sharp, spring loaded probes are precisely mounted. The jig is pressed against the circuit board along guide rails so that the floating point itself must be carefully selected. Low impedance inputs and outputs with reasonable signal levels do much to eliminate pick-up and shunt capacity effects. High accuracies of measurement can be achieved by exercising reasonable care.

An example of good module design for automatic testing is seen in *Fig.* 3. Over 130 components are mounted on the module, forming a six-channel inverter-amplifier assembly. All the required test points are brought out to connector terminations. This design not only affords complete access during module test but carries test facilities over into the next assembly by means of access in place through the test connector.

▶ Test Equipment

Design of the automatic test equipment is directed by the needs of the manufacturing process: The test equipment must be easily modified to meet the requirements of any module; experience dictates the necessity for a ready means of changing the functions in the automatic sequence to keep pace with design modifications to the module; since permanent test records are required they can be obtained by automatic print-out; displays are needed to keep the operator informed of test progress and results; manual control and entry must be available; the test station should also serve as a manual trouble-shooting station for isolating faulty components; and lastly, provision must be made for the use of standard manual test equipment. A block diagram of an

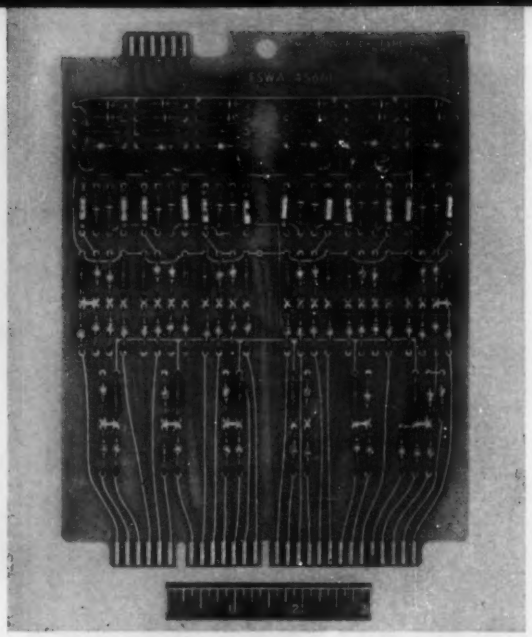


Fig. 3—Testing operations are influenced by design and layout of the module board. The picture illustrates a well-designed module for a single function. Test points are brought out to connector terminations.

automatic test station embodying these principles is shown in *Fig.* 4.

The programmer converts a set of permanently coded instructions into electrical impulses which are translated into unique signals by the decoder. Programmers fall into three general categories. In order of increasing flexibility they are: Prewired stepping-switch program; pin-board or patch-panel program; and tape or card program. Unless a large production volume of one type of module is anticipated, the programmer must be selected with flexibility in mind. For this reason, interest has centered on the third category. Punched tape or cards provide a permanent, easily stored program medium which can be readily altered to accommodate design changes. The program can be quickly changed to keep pace with short production runs. Copies can be made by automatic tape/card preparation machines if more than one test station is to be put in operation.

The signals from the decoder set up the various generating and analyzing devices. In *Fig.* 4 they are shown dotted since the test equipment must be able to expand or contract to meet the test requirements of the module. To conserve capital outlay these devices are plug-in units which can be added to or removed from one test station for use in other as the occasion demands.

The comparator is a decision making element which compares the measured value against upper and lower limits obtained from the programmer. Logistics and quality control make some form of permanent recording device mandatory. An automatic printer which prints out the test number and test result serves to record the performance of the module under test. The data is readily analyzed for design performance as well as quality control. As previously noted, a manual test capability is provided for fault isolation to the piece part. The automatic test equipment provides the module with power and stimuli. The manual test equipment, an oscilloscope for example, is used to probe the components when access is difficult or automation is too expensive.

The adapter couples the test equipment to the module being tested. In its simplest form it is a

JUSTIFYING AUTOMATIC TEST EQUIPMENT

Development of General Formula

(a) Cost of basic manual equipment is approximately $1880 (signal generators, $500; power supplies, $600; voltmeter, $400; holding fixture, $100; interconnecting hardness, $280).

(b) Cost of basic automatic equipment is approximately $8100 (programmer, $1200; decoder, relay, $400; comparator, $400; printer, $800; displays, $250; coupler, $2500; digital voltmeter, $1800; interconnecting harness, $750).

(c) Assume direct labor-plus-overhead rate of $6.00 plus allowance of 10 per cent for repair and recycle of faulty units. Total hourly rate is $6.60.

(d) Let N = number of units tested; T = manual test time (hours); t = automatic test time (hours).

(e) Cost of manual testing = $1880 + 6.6NT
Cost of automatic testing = $8100 + 6.6Nt

(f) Solving above equations simultaneously to obtain production quantity for which manual testing costs are equal to automatic testing costs:

$$N = \frac{942.4}{T - t}$$

(g) As simplified approximation use:

$$N = \frac{1000}{T - t}$$

Some Applications of General Formula

(a) For audio amplifier subassemblies, time values are on the order T = 0.4 and t = 0.08. With these figures:

$$N = \frac{1000}{0.4 - 0.08} = 3125 \text{ units}$$

which would justify automatic equipment. As a further comparison, for this number of units, automatic testing would require approximately 250 hours compared to 1250 hours for manual testing.

(b) For telemetry amplifier subassemblies, time values are on the order of T = 1.26 and t = 0.17. These yield a value:

$$N = \frac{1000}{1.26 - 0.17} = 917 \text{ units}$$

(c) For regulated power supply subassemblies, time values are on the order of T = 1.75 and t = 0.2. With these values:

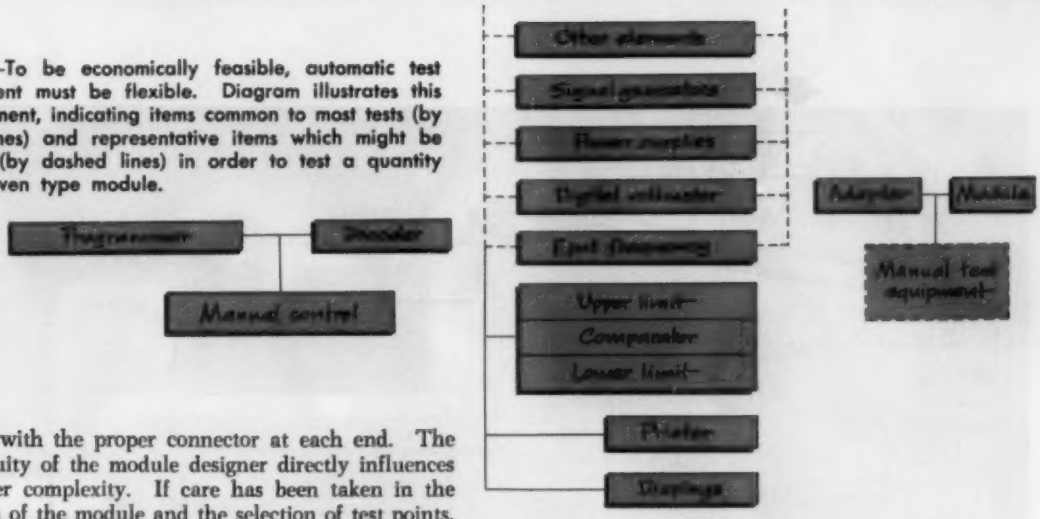
$$N = \frac{1000}{1.75 - 0.2} = 645 \text{ units}$$

(d) For computer logic boards, time values are on the order of T = 3.0 and t = 0.25. For such values:

$$N = \frac{1000}{3.0 - 0.25} = 364 \text{ units}$$

Once again comparing total hours, automatic testing would require 91 hours as compared to a manual test time of 1090 hours.

Fig. 4—To be economically feasible, automatic test equipment must be flexible. Diagram illustrates this requirement, indicating items common to most tests (by solid lines) and representative items which might be added (by dashed lines) in order to test a quantity of a given type module.



cable with the proper connector at each end. The ingenuity of the module designer directly influences adapter complexity. If care has been taken in the design of the module and the selection of test points, the adapter function is reduced to a minimum. The inclusion of impedance matching devices and amplifier in the adapter may be required to match the module to the test equipment.

▶ Test Planning

The actual test requirements are developed in parallel with the module design. This is best carried out by writing a narrative-type test description, termed a "test procedure," for the module during development. The test procedure gives a quantitative description of each test to be performed, noting the values of all stimuli and measurements together with tolerances and points of application.

The test procedures, when completed, are then translated into an alphanumeric code so that the data can be entered into a punched tape ready for use. The transition from "test procedure" to "data sheet" serves to ready the information for coding and will also establish the switching and control requirements. The data sheets, in effect, translate the narrative operation into a step-by-step coded sequence where every step is controlled by a binary logic operation. Relay or cross-bar switch control are typical operations to be exercised in sequence.

When all the data sheets have been prepared, the information contained is analyzed for equipment requirements by reviewing each type of module and each function to be tested. The basic equipment includes the programmer, manual control keyboard, decoder, comparator, printer, and displays, *Fig.* 5. Standard test equipment requirements are the rate table, audio oscillators, power supplies, digital voltmeter, and servo analyzer. Each subassembly and module will require an adapter for the special functions and switching noted in the test procedure and data sheets.

With proper design, an assembled test stand can automatically test all the modules, subassemblies, and final assemblies of a system. The punched tapes required can be readily altered to accommodate design changes and changes in test procedure tolerance. The test stand is readily modified from one test configuration to another to support production runs.

When applying automatic test techniques a careful analysis of merits and disadvantages must be made (see box entitled "Justifying Automatic Test Equipment"). Weighing relative cost factors, the production run must be large enough so that cost saved in testing and training will offset the expenses of programming and adapter fabrication. If the module design is such that extremely complex measurements must be made, then manual equipment is likely to be the best solution. Finally, where speed of testing is not a factor, but a large number of repeated measurements must be made then automation becomes desirable to achieve a high degree of test repeatability.

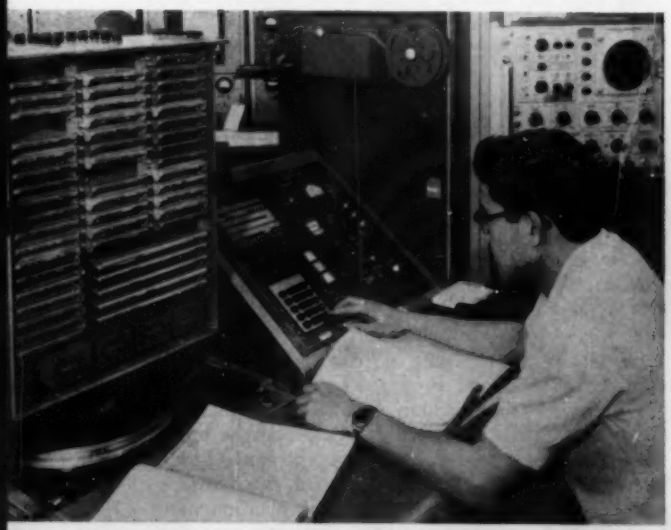
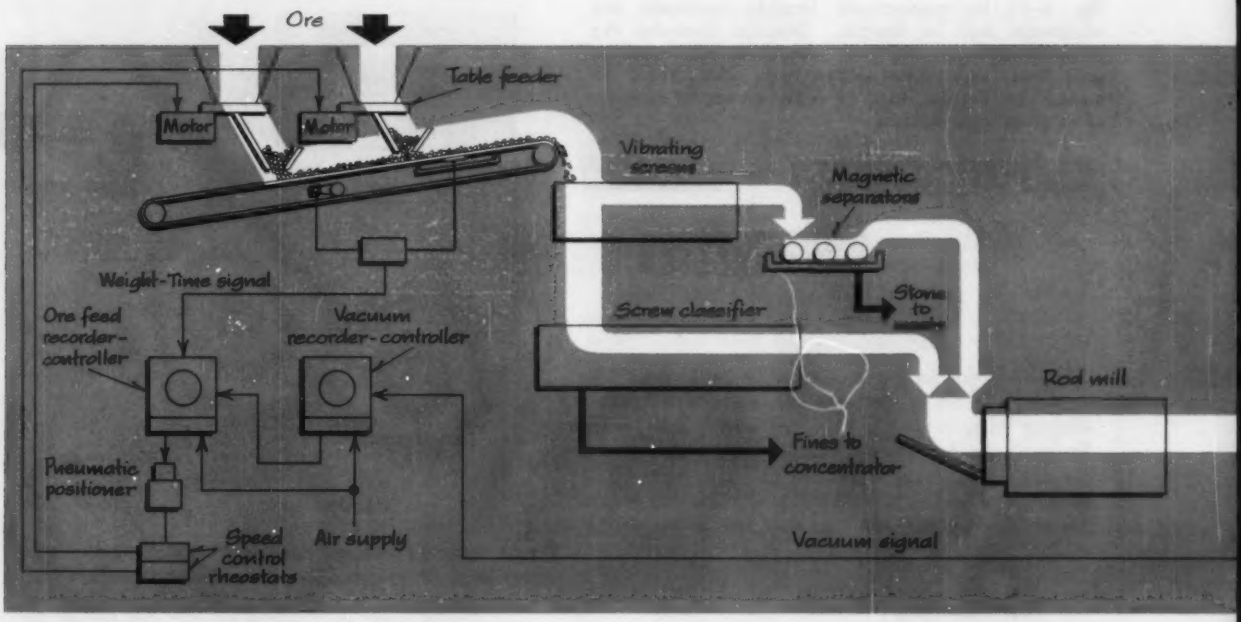


Fig. 5—A basic testing station employing principles discussed in this article is shown. Component parts of test station range from automatic items, such as punched tape reader, to oscilloscope and other types of standard manual test equipment.



ORE GRINDING CASCADE CONTROLLED

TO COMPENSATE FOR MATERIAL VARIATIONS

KEY TO efficient, economical ore grinding is to keep the mills operating at full load while producing ground products with uniform, acceptable screen analyses. This is often difficult, however, because of variations in the size and hardness, and hence grinding characteristics, of the material being processed. A solution to the problem, adopted by an eastern iron ore processor, includes a recirculating arrangement whereby materials may be returned to a ball mill for reprocessing and automatic controls that regulate the input of raw materials to the process in accordance with ball mill load conditions.

▶ Grinding Process

As shown in the schematic flow diagram of a grinding line, *Fig.* 1, material is removed from each of two ore bins by a table feeder and placed on a belt conveyor. From the belt conveyor, the combined materials are passed to a vibrating screen device that sifts out initial fines. These fines are further processed in a screw classifier that releases some of the material to a concentrator. Material other than initial fines passes from the vibrating screens to magnetic separators where stones are removed. Magnetic material retained by the separators is then introduced to a rod mill together with material from the screw classifier.

Output of the rod mill is fed to a ball mill that discharges to a sump. From the sump, ground material is pumped to a cyclone classifier. The classifier has two outputs. Fines are discharged at the top of the unit and are moved to the concentrator. Large, hard particles fall to the bottom of the classifier and are passed through a rotary lock to a magnetic separator. From the separator, magnetic materials are returned to the input end of the ball mill for reprocessing.

If the basic ore becomes harder, reducing the mill capacity, the recirculating load increases. This

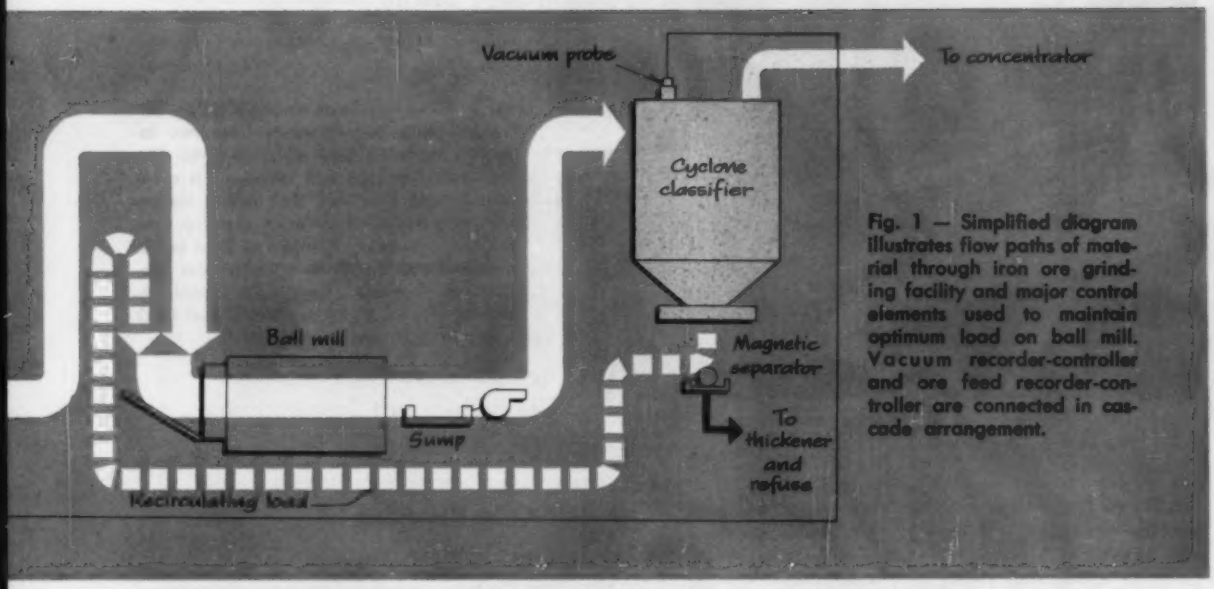


Fig. 1 — Simplified diagram illustrates flow paths of material through iron ore grinding facility and major control elements used to maintain optimum load on ball mill. Vacuum recorder-controller and ore feed recorder-controller are connected in cascade arrangement.

shows up as an increase in the vacuum in the cone vortex of the cyclone.

Vacuum signals from a probe at this point are fed to a vacuum recorder-controller whose output affects the set point of an ore feed recorder-controller, *Fig.* 2. The two instruments are connected in cascade so that, if the vacuum increases, the air pressure signal from the vacuum recorder-controller will decrease and lower the set point of the ore feed recorder-controller.

The set point of the latter instrument corresponds to a command signal for a specific ore feed rate. Thus, if the vacuum in the cyclone classifier increases, a lower feed rate will be called for. If the vacuum decreases the ball mill can accept more product from the rod mill, and a higher input feed rate will be commanded.

A signal representing the actual rate of ore feed is introduced to the ore feed recorder-controller by a feedback path from the belt conveyor, *Fig.* 3. The magnitude of this signal reflects both instantaneous weight of material at a check point on the belt, and belt speed. Weight is sensed by a resistance-type load cell mounted on a weighing carriage, and speed is sensed by a tachometer coupled to the belt.

The two signals—representing command and

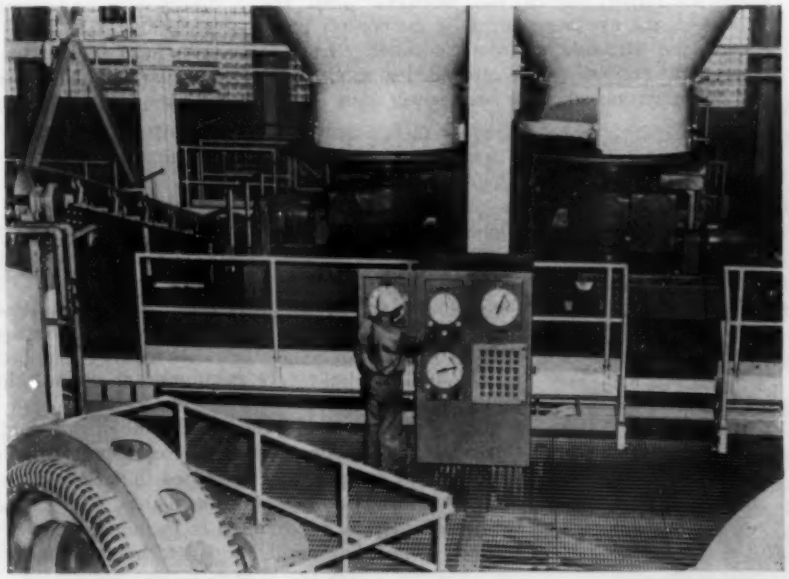


Fig. 2—Automatic controls are centralized on panel at input end of process. Controls adjust speeds of table feeders at bottoms of ore bins, background, to regulate material input rates in accordance with ball mill requirements.

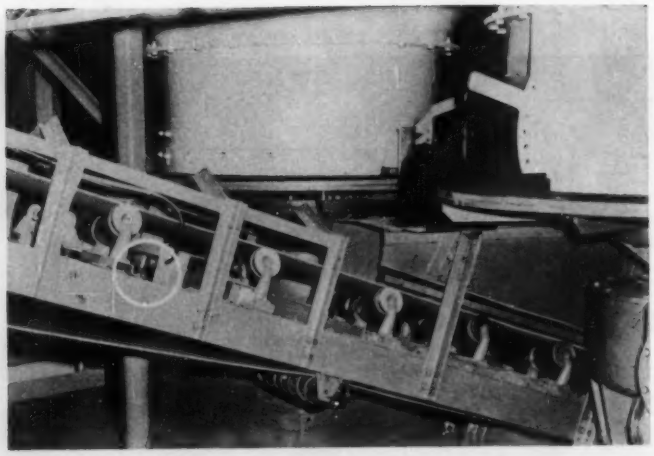


Fig. 3—Close-up shows material being discharged onto belt conveyor from two table feeders associated with ore bins. Circled component on belt conveyor is a resistance-type load cell that senses instantaneous weights of material passing over weighing carriage. Output of load cell is combined with that from a tachometer connected to the belt. Composite signal, reflecting rate of material flow, is fed back to ore feed recorder-controller.

actual ore feed rates—are compared in the ore feed recorder-controller. If they are the same, no control change will result. But if they are different, an error signal will result that will modify the air signal output from the instrument.

The output signal from the ore feed recorder-controller is used to drive a pneumatic positioner. The positioner, in turn, adjusts a pair of speed control rheostats. If the output signal changes, signifying a difference between actual and command ore feed rates, the rheostats will be moved to a new position. This will change the voltages supplied to the table feed drive motors and thus alter their speeds.

For example, if the vacuum in the cyclone classifier increases—indicating an increase in the recirculating load to the ball mill—the output signal from the ore feed recorder-controller will move the rheostats in a direction to decrease the speed of the table feeders. An increase in the speed of the table feeders will be called for if the cyclone vacuum decreases. These corrective actions will continue until the vacuum in the cyclone returns to the control point set on the vacuum recorder-controller. In this manner, the ore feed rate is controlled so as to maintain an optimum, constant horsepower load on the ball mill.

▶ Production Recording

Another feature of the installation is provision for recording the total tonnage of materials introduced to the system during any desired time period. This is accomplished by means of an integrator in the ore feed recorder-controller. The integrator converts the feedback signal from the belt conveyor into a form that can be displayed as cumulative tonnage on a digital counter.

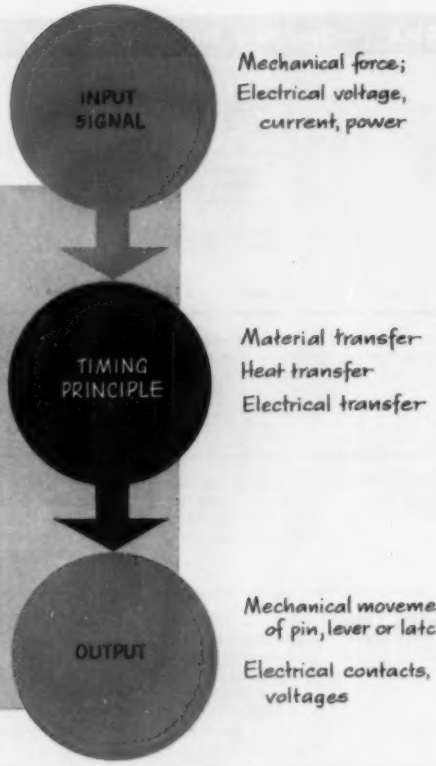
The control system described has been applied to four grinding lines. In addition, belt weighing systems—including weigh carriages, load cells, tachometers, indicators, and recorders—have been installed at other places in the plant to measure and record total outputs of iron ore concentrates and pyrites. Tape printers associated with the weighing systems provide permanent records of production, and can be used to determine tonnages placed in individual ore cars.

The automatic controls for ball mill loading were designed in co-operation with the user's engineers. These controls, and the weighing systems, were built by Trans-Weigh Co. Over-all benefits of the installation include solution of the mill loading problem and availability of printed records of tonnages for management and cost accounting purposes.

can we help?

It has been pointedly mentioned at various times that in engineering automated systems new as well as old techniques and devices may prove extremely useful. Practical results require the investigation of all available equipment that can contribute to the effective development of suitable automatic lines. Information on such equipment is presented in various departments of the magazine each month as useful data become available. To aid in obtaining detailed data for further evaluation a post card is included on page 19. Take advantage of this service. The Editors will be glad to help in this or any other way.

Fig. 1—Basic elements of a timing device for automatic control circuits include: An input signal, a timing principle or method, and an output. Time relationship between receipt of an input signal and production of an output can be controlled.



Essential components in many automatic control schemes, timing devices are employed throughout business and industry. To assist designers and users in properly selecting and applying these components, the author presents a survey of basic types of timers, characteristics, operating principles, and limitations. Typical applications of timers, and reasons for the selection of particular devices, are mentioned.

SELECTING AND APPLYING

TIMING DEVICES FOR AUTOMATIC CONTROL

By **JOHN C. PONSTINGL**, Engineering Supervisor, Consulting and Application Engineering Westinghouse Electric Corp., Cleveland, Ohio

TIME is a controlling factor in the success of many automatic operations and processes. When used to delay, sequence, or program equipment actions, accurate control of time is a vital necessity throughout industry. Because of the importance of this function, many types of timing devices have evolved for use in industrial control applications. Properly applied, these devices can help achieve safe and consistent operating conditions, better products, and lower process or production costs.

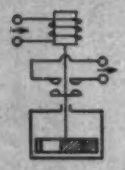
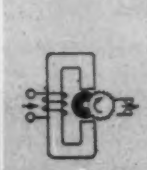
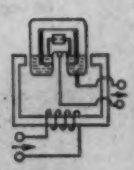
What Is a Timer?

A timer is a device that is actuated by an input and, after a controlled delay period, produces an output. The time interval between the input and output can be controlled. In general, three elements are essential to a timer: An input signal, a timing method, and an output, *Fig.* 1.

Typical timer inputs include mechanical forces and electrical voltages or currents. A mechanical force input, for example, could be the manual turning of the dial of a spring-operated, escapement-type timer. An electrical input signal might be a voltage used to energize or de-energize an electromagnet, motor, or circuit of a timing device. Time-range adjustments usually can be made at the input point of a timer.

Timing operating principles can be classified under three broad categories: Material transfer, heat transfer, and electrical transfer. The material transfer principle involves the moving of a metered quantity of material from one location to another in a restricted manner. Pneumatic, mercury, dashpot, and motor timers all fit in this category. In the motor

TABLE 1—Operating Principles of Some Common Types of Timing Devices

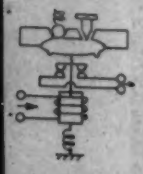
Type	Dashpot	Escapement	Inertia	Induction Disc	Motor	Mercury
						
Input (initiates timing cycle)	Voltage—solenoid moves piston.	Voltage—applied to solenoid. On manual device, a spring is wound.	Voltage—applied to relay coil.	Voltage—applied to solenoid	Voltage—starts clock motor.	Voltage—pulls plunger into mercury.
Motivating Force (sustains time period)	Voltage—moves piston. Time is inverse function of voltage.	Solenoid plunger moves. Time is inverse function of voltage and resulting pull.	Voltage—applied to relay coil.	Solenoid tends to rotate disc.	Clock motor drives gear train or cam shafts.	Plunger displaces mercury, forcing gas in bell through porous disc or orifice.
Restricting Media (controls time period)	Time is inverse function of clearance and orifice size, and direct function of distance piston moves.	Escapement and inertia wheel move solenoid plunger. Time is a function of oscillating period.	Large mass on relay armature delays movement.	Magnetic flux slows disc rotation. Time also function of contact spacing.	Clock motor speed and gear train ratio. Time a function of distance contacts or cams must move.	Porous ceramic disc or orifice. Time is inverse function of gas leakage rate.
Output	Contacts—actuated by movement of piston.	Contacts—actuated by movement of solenoid plunger.	Contacts—actuated by movement of armature.	Contacts—actuated by rotation of disc.	Contacts—actuated by movement of gear train.	Mercury completes an electrical circuit.
Typical Time Range	1 to 60 seconds	1 to 6 seconds for magnetic; days for manual.	0.1 second maximum	1/6 to 5 seconds	1 second to days	0.2 second to 20 minutes
Accuracy	± 20 per cent	± 15 per cent for magnetic; 1 second for manual.	± 10 per cent	± 10 per cent	0.1 second for synchronous motor; about 5 per cent for dc motor	± 10 per cent
Reset Time	Instantaneous with check valve	Instantaneous with ratchet release	Same as time period	0.1 second	Instantaneous with release clutch or ratchet	Instantaneous

timer, for example, the gear train in the device is a metered quantity; that is, a predetermined number of gear teeth must be moved a certain distance in a given time period.

In the heat transfer method, heat is transferred from an electrical heater to a metallic member. As heat is absorbed by the latter element, the metal stretches, bends as in a bimetal, or melts as in a solder-pot relay. Various methods are used to transfer heat to the metallic member. In the case of flasher timers, for example, the heat is generated within the member itself to minimize ambient temperature effects. Thermal timers find frequent application in motor-protective devices.

The electrical transfer principle, also called energy storage, is an extremely flexible source of timing and is especially suited for use with static controls. Inductive timers and capacitor-charge and discharge schemes are commonly used in industrial applications.

Commercial timers are usually identified by their timing principles. A pneumatic timer, for example, depends for its operation on the time for air to flow from or into a metered chamber through a calibrated

Pneumatic	Thermal	Inductive Decay	Inductive Buildup	Capacitor Discharge	Capacitor Charge	Electronic
	Heat Transfer			Electrical Transfer		
Voltage—solenoid forces diaphragm or bellows to expel air from chamber.	Voltage—applied to heater element.	Voltage—removed from relay coil.	Voltage—applied to winding on magnetic core.	Voltage—disconnected from circuit.	Voltage—charges capacitor.	Same as capacitor discharge type
Bias spring moves diaphragm or bellows and pulls air into chamber.	Metal expands or moves when heat is applied.	Gravity or spring pulls relay armature.	Ampere turns cause buildup or change in magnetic flux.	Energy stored in capacitor.	Charging voltage.	Same as capacitor discharge type
Needle valve. Time is inverse function of orifice size.	Time a function of heat transfer rate, thermal capacity of metal, and contact spacing. Inverse function of voltage.	Inductance, increased by copper ring, delays flux decay and operate time. Spring tension decreases time.	Inductance of magnetic circuit delays buildup or change in flux.	Resistor sets capacitor discharge rate. Time a function of resistance, capacitance, and voltage.	Charging rate determines time period.	Same as capacitor discharge type
Contacts—actuated by movement of diaphragm or bellows.	Contacts—actuated by movement of heated metal or bimetal.	Contacts—actuated by movement of armature.	Contacts—or voltage alone if relay action is not desired.	Contacts—or voltage alone if relay action is not desired.	Contacts—or voltage alone if relay action is not desired.	Contacts—or voltage alone if relay action is not desired.
0.2 to 200 seconds	0.5 second to 5 minutes	0.5 to 3 seconds	1 second maximum	0.1 to 30 seconds	0.2 to 20 seconds	0.01 to 30 seconds
± 10 per cent	± 50 per cent	± 5 per cent	± 5 per cent	± 5 per cent (depends upon device that senses output voltage)	± 5 per cent	± 1 per cent
Instantaneous with check valve	Up to 2 minutes	Approximately 10 per cent of time period	Same as time period	10 per cent or less of time period (depends upon charge circuit)	10 per cent of time period	10 per cent of time period

orifice. A thermal timer uses the time to heat a metallic element for its control. There are exceptions, however; the name "electronic timer" does not necessarily indicate that a specific timing principle, such as capacitor-discharge, is used. Adjustments can be made in the portion of a timer embodying the timing principle and usually provide the largest time range.

Outputs from timers include mechanical movements of pins, levers, or latches; the opening or closing of electrical contacts; or generation of voltages or other electrical signals. Adjustments to timer outputs are usually manual or made on the devices. Ordinarily these adjustments are of a mechanical nature.

Actually, any phenomenon that depends upon time may have merit for incorporation in a timing device. Some of the principles commonly employed in commercial timers are outlined in TABLE 1, along with data on typical time ranges, accuracies, and reset times. It should be emphasized that the diagrams accompanying TABLE 1 illustrate timing principles and do not necessarily reflect physical configurations of real components.

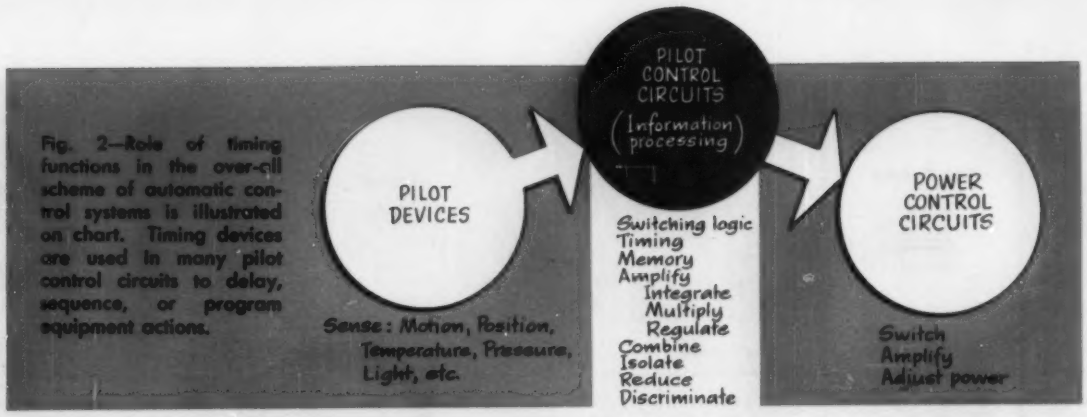


Fig. 2—Role of timing functions in the over-all scheme of automatic control systems is illustrated on chart. Timing devices are used in many pilot control circuits to delay, sequence, or program equipment actions.

Control Applications

Where are timers used in the field of automatic control or in complete control systems? The control art may be divided into three general areas: Pilot devices, pilot control circuits, and power control circuits, *Fig.* 2.

Pilot devices are used to sense conditions such as temperature, pressure, position of material in a machine, or a signal from an operator. In pilot control circuits, information processing is accomplished by logic (sequential switching), memory, and timing devices. For example, timers are often a necessary part of pilot control circuits for programming controls. Pilot control circuits usually actuate power control devices to switch, amplify, or adjust power levels. Thus, in typical industrial applications, electrical signals from transducers, limit switches, and pushbuttons are processed in control circuits (which may include timers) to operate motors, solenoids, and other devices.

TABLE 2—Factors to Consider in Applying Timing Devices

Character of Time Period
- Time Range
  - Time intervals, time delays, dwell periods, sequencing, programming, acceleration time, pauses, repeat cycling, intermittent timer, continuous timer, elapse timer, cumulative timer, inverse time
- Fixed Time Intervals
- Adjustable Time Intervals
  - Range of adjustment
  - Manual or automatic adjustment
  - Local or remote adjustment
- Reset Time
- Accuracy—repeatability of time period
- Fail Safe—operates without power
- Sensitivity to Variables—ambient temperatures, voltage fluctuations
- Power Source—ac, dc

Co-ordinating Timer with Control System
- Type of Input Signal
  - Manual
  - Mechanical—operated by levers, cams, etc.
  - Electrical
    - Digital—limit switches, pushbuttons
    - Analog—motor currents, power fault currents
- Type of Output Signal
  - Mechanical—pin, lever, trip latch
  - Electrical—contacts, voltages
- Environment—space, vibration, dust, corrosion
- Cost
- Life
- Maintenance

Selecting a Timer

Selection of a timing device requires familiarity with the requirements of the application as well as the basic characteristics of available timers. Often, failures occur or results are inadequate because all of the application factors were not established or limitations of a chosen timing device were not known.

Timing devices are best selected by first outlining the conditions under which the device must operate and the functions required, Table 2. Usually, the time range is the first condition that must be satisfied, *Fig.* 3.

If delay periods of less than a second are needed, as for a spot welder, an inertia or stored energy type timer such as a capacitor-charge or inductive device should be considered. Since the timing range in such an application must be variable, highly repetitive, and possess good repeat accuracy, an electronic timer using a capacitor-discharge principle may be the only answer. Ability to change the timing range with a rheostat, which may be adjusted remotely, is another advantage of the capacitor-discharge principle. Pneumatic timers have been used for spot welders where the operating rate is not high. However, the life or wearing qualities of the timing device may rule out this type for some spot welding applications.

In optimizing control systems, such as Opcon, a timer provides the delay necessary for a process to reach equilibrium after a change has been made. Some processes require several hours to stabilize after a change has been made. Some of this can be transport time. In other words, material may have to travel over a conveyor or through a mixing system before reaching the batch or end-product stage

where a change can be detected. In Opcon, a timer, adjustable up to a 240-minute interval with instantaneous reset, delays further corrections in the system.

The program plan of a timer is determined by the operating functions of the application. For example, the function, "start timing period when signal is applied," might describe the need for a delay between accelerating steps of a resistance-type motor starter. Pneumatic timers can be used in this application.

A "start timing period when signal stops" function may be used to delay the operation of the under-voltage attachment on an oil breaker after voltage reduction. By using a capacitor-type timer, delays of several seconds are possible.

Programmed time pulses as found in a diecasting machine, with pauses for loading, heat cycle, etc., call for a multicam-operated motor timer in order to ensure proper sequencing.

Electrical input signals to a timer may be voltage pulses as used in static controls, or steady-state voltage outputs from other switching devices. This does not change the time period of the timer. However, if timers operate on fixed-input signals, voltage, frequency, and ampere ratings should be considered.

The availability of reliable rectifiers makes possible operation of practically any dc timer on ac power. Inductive timers, for example, are operated by direct current, but by adding a selenium-rectifier bridge, they are also effective in ac circuits. Most other timers are available with ac or dc operating coils. On motor-operated timers, ac power adds a degree of accuracy because a synchronous motor can be used.

Usually the time interval of fixed-input timers can be varied by adjusting the basic mechanism of the timing principle. In the case of a pneumatic timer, for example, the orifice size is changed with a needle valve. In an inductive timer, the rate of decay is changed by varying the number of short-circuiting rings. Less expensive and simplified versions of these timers can be obtained by omitting the adjustments. In applications where a fixed delay (for instance, for tube warmup in electronic equipment) is adequate, such fixed-time-delay devices are an economical choice.

If input voltage or current varies proportionally to changing conditions of the application, the timing period will also vary. If the time-delay range must be automatically changed to suit application conditions, this adjustable time characteristic is just what is needed.

If the time delay must be inversely proportional to signal strength, as in the case of an overload relay, a thermal timer with a timer interval inversely proportional to input current would be applicable. For instance, the time period of a motor-overload relay must be inversely proportional to the overload current. A 30 per cent overload can be tolerated longer than a 200 per cent overload. In this case, a signal proportional to the motor current flows through an overload heater which operates an overload relay; as the current increases, the trip time decreases.

A dashpot timer can also be used for motor protection. Here, the current in the operating coil is proportional to the motor current. The greater the magnetic pull, the faster the piston or dashpot moves. To be used as an overload relay, the time-current characteristics of the timer must match the allowable heating curve of the motor.

The nature of the control circuit may affect the selection of a timing device. For example, if it is to be used in a switching circuit, the timer should have output contacts. Standard 110-volt, 10-ampere control ratings usually apply. If a timer is used with a magnetic amplifier regulator—where delays on the order of seconds may have to be introduced to prevent hunting—inductive and capacitor charge systems using electrical transfer principles are best suited. For delays up to 1 second, a damping winding can be added to the magnetic amplifier core. Delays of several seconds can be obtained with a capacitor-delay circuit.

In general, high accuracy contributes most to the cost of a timer. In electronic timers, additional circuits can be incorporated to compensate for variables, such as power-voltage fluctuations, and also to improve the accuracy of capacitor-discharge voltage sensing. These add to cost. However, reliability does not necessarily increase cost. Solid-state devices such as rectifiers and transistors are making possible relatively low-cost, reliable timers.

As applications and resulting control requirements become more exacting and complex, it is increasingly important that all of the basic needs of a timing problem be recognized and evaluated. Knowledge of the fundamental characteristics and limitations of available timers will then help guarantee that a proposed application will meet operational requirements.

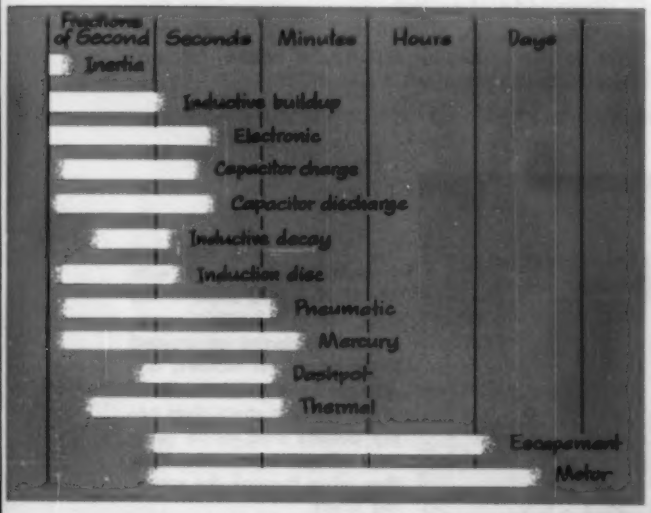
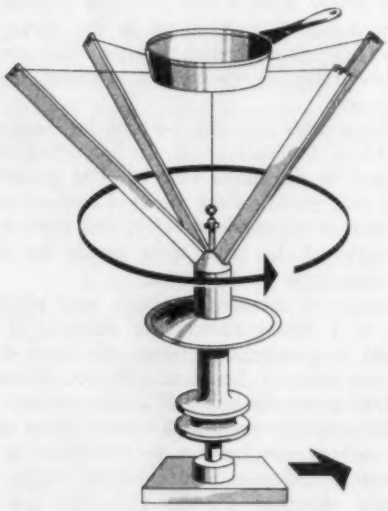


Fig. 3—First step in selection of a timing device is usually to match the time range of a device with application requirements. Conveniently displayed on chart are typical time ranges of several common types of timing devices.

LINE SPRAYS AND FIRES PORCELAIN COATINGS

FINISHING operations for porcelain-coated cast iron cookware have been improved, and production has been speeded, through the adoption of automatic equipment in the production line for Prizer-Ware products manufactured by Textile Machine Works. Principal equipment items in the line include spray painting booths, an infrared dryer, a buffing station, and a roller hearth furnace.



In the spraying operation, cookware castings are placed on special fixtures that travel on an endless chain through two automatic spray booths, *Fig.* 1. In one of the booths, the products are coated on their outsides as they pass multiple spray heads. The fixtures are rotated during this operation. Coating of the insides of the castings is accomplished in a similar manner in the other spray booth, and may involve a different color of porcelain.

After leaving the automatic spray booths, the coated castings travel on the fixtures through a third spray booth where touchup coatings may be applied manually. Some items with irregular surfaces, such as the knobs on cookware lids, are regularly sprayed in this booth. After spraying, the products move through an infrared radiant energy dryer that removes moisture from the coating material, and then move to a buffing station. As the products arrive at the buffing station, an operator takes them off the fixtures and buffs them to remove excess sprayed material. The products are then placed in single layers on pallets which are conveyed through the furnace.

In the electrically heated roller hearth furnace, the porcelain coatings on the products are fused at temperatures of 1300 to 1400 F. Time required for completion of this process is ½ hour. As the finished pieces leave the furnace they are transferred automatically from the pallets to an elevated conveyor line leading to an inspection station.

On the inspection line, operators examine each piece for flaws and reject those items which do not meet inspection standards. One of the tests performed is measurement of coating thickness with an electrical probe device. Coating thicknesses are maintained within a maximum of approximately 10 to 12 thousandths of an inch. Cookware products that pass inspection are allowed to proceed on the conveyor to the packaging department where they are prepared for shipping.

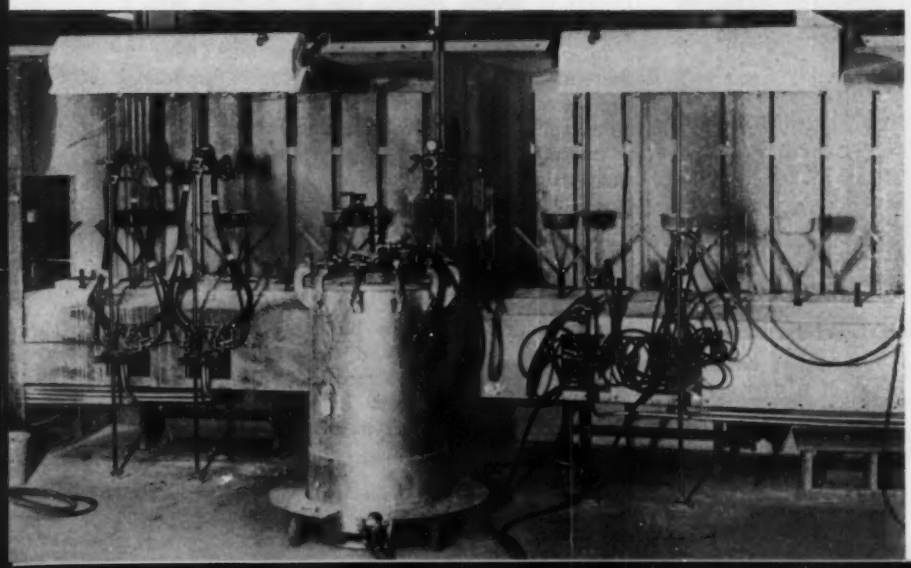


Fig. 1—Cast iron cookware products are sprayed with porcelain in two steps in this dual spray booth setup. Pieces, supported on crossed wires in special fixtures, are conveyed through booths where multiple spray guns apply outside and inside coatings. Fixtures are rotated as they move through the spraying areas.

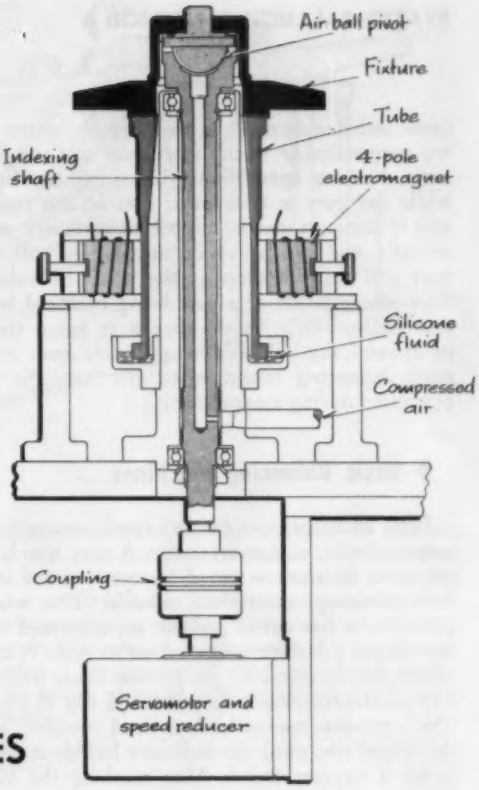


Fig. 1—Simplified sketch shows the internal mechanism of a recently developed nonrotating static balancer. Part to be balanced is placed on fixture which is supported by air ball pivot. Heavy side of the part causes the tube affixed to fixture to tilt within the magnetic field created by a 4-pole electromagnet. Change in magnetic reluctance between each pole face and the tube surface is measured and used to electronically produce an amount of unbalance signal and an angular location of unbalance signal. The angular location signal is then used to actuate the servomotor which rotates the fixture and part to the proper position for correction of the unbalance.

STATIC BALANCING METHOD

SHORTENS PRODUCTION CYCLES

Nonrotating static balancing systems that have a shorter cycle time per part but retain the precision and accuracy of rotating balancers have been developed by a manufacturing research group for use in integrated production lines. This report discusses their method for determining the amount and angular location of part unbalance. A key feature is an electromagnetic arrangement to detect mechanical displacements.

WHEN unbalanced parts are rotated at high speeds in a piece of equipment, vibratory forces are created which cause excessive wear on bearings, increased oil consumption, increased noise levels, and decreased effective power if the part acts as a flywheel. If great enough, the induced vibration can quickly cause the equipment to shake to pieces or to fly apart. Lesser vibration can cause innumerable difficulties and greatly increase the amount of maintenance required to keep the equipment running.

Therefore, balancing of rotating parts prior to assembly into equipment has become an important part of producing a smoothly running piece of equipment. A part can be either statically or dynamically balanced. The choice of which type of balancing should be used depends upon the configuration and end use of the part. Generally, a part whose length along its rotational axis is considerably greater than its diameter, such as an engine crankshaft, must be dynamically balanced to eliminate force couples, an unbalance in two planes which tends to displace the ends of the part in opposite directions. Conversely, a part whose rotational diameter is considerably greater than its axial length can be balanced statically, and remaining force couples are negligible in most applications.

In dynamic balancing, the part must be rotated in order to establish the angle and amount of unbalance due to force couples. This is required be-

STATIC BALANCING METHOD

cause unbalances occur in two or more planes which are perpendicular to the rotational axis and usually some distance apart. Static balancing can be done while the part is stationary, that is, the rotational axis of the part can be supported vertically or horizontally and the heavy or unbalanced side of the part will tend to drop at the point of unbalance. However, rotation of a part being balanced is not a true indication as to whether it is being statically or dynamically balanced for parts are spun in many static balancing machines to eliminate the effects of friction during measurement.

Basic Balancing Machines

Parts balancing can be performed manually, semiautomatically, or automatically. A very simple manual static balancer is found in many service stations for balancing automobile wheels. The wheel is placed in a horizontal position on a vertical spindle containing a bubble indicator on its end. When the mechanism is released, the spindle floats freely, and any unbalance causes the wheel to dip to one side. The operator manually lays lead weights around the wheel rim until the indicator bubble is centered under a circular target. After marking the location of the weights, the operator removes the wheel and hammers the weights in the indicated points on the wheel.

Automobile wheels are also balanced dynamically on semiautomatic equipment. In this case, the wheel is locked on a horizontal spindle, and a friction drive against the tire causes the wheel to rotate at a high speed. When the wheel vibrates due to unbalance, the operator notes the angles and amounts of unbalances in two planes on instruments on the equipment. When the wheel is stopped, the angles are measured from a reference mark on the tire, and proper weights are added. The tire is again rotated at high speed to check the accuracy of the balancing. This type of dynamic balancing is much superior to the bubble indicator type of static balancing.

Balancing of parts on a production line stems from these two basic types of balancers. Dynamic balancing is required for many parts due to their configuration and end use.* However, when a part must be spun at high speed as in dynamic balancing, considerable time is added to a balancing cycle to allow a part to reach operating speed and to stop the part for correction. For example, spinning a part up to speed could require about 5 seconds and slowing it down again could take about five more seconds. Compared with an average cycle time of about three seconds for a nonrotating static balancer, it can be seen that a much higher production output can be obtained when a static balancer can be used. Since this type of static balancer usually does not require any rotating parts, wear and tear on the machine are minimized and maintenance is low.

In high production industries the trend has been to develop nonrotating static balancers that would retain the accuracy and precision of rotating balancers. In addition to reducing the cycle time per part, nonrotating balancers are more easily integrated into automated facilities that load and unload parts into the balancing equipment and correct the unbalance by automatically adding or removing material from the part. Much development work along these lines has been carried out by the Special Problems Dept. of the Research Laboratories, General Motors Corp.

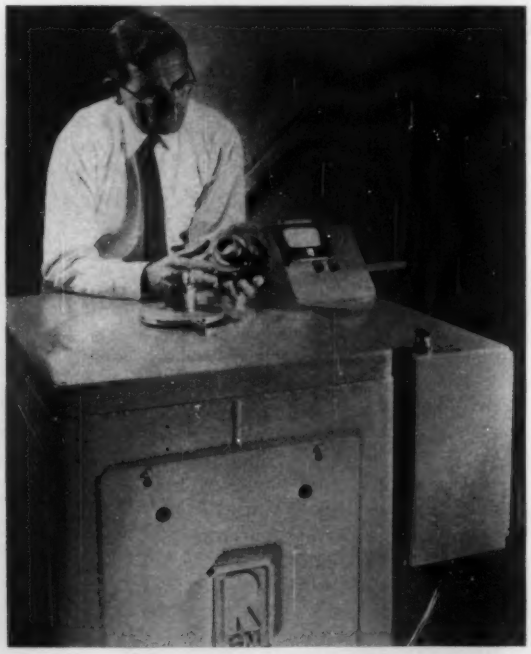


Fig. 2—Experimental model of a nonrotating static balancer that uses the electromagnetic detection method is shown. The machine was built to balance the automatic transmission rear planet carrier held by the man. Approximately three seconds after the part has been placed on the fixture and the pushbutton pressed, the unit has measured the unbalance, registered the amount in ounce inches on the meter, and indexed the heavy side to the stationary pointer. The unit is capable of balancing precision parts to less than 0.01 ounce inches unbalance.

Nonrotating Static Balancing

In 1955, the Research Laboratories designed a machine for automatically indicating static unbal-

*W. M. Gruber, "Crankshaft Line Uses In-Line Production Balancing," AUTOMATION, Vol. 5, No. 2, February 1958, pp. 80-83.

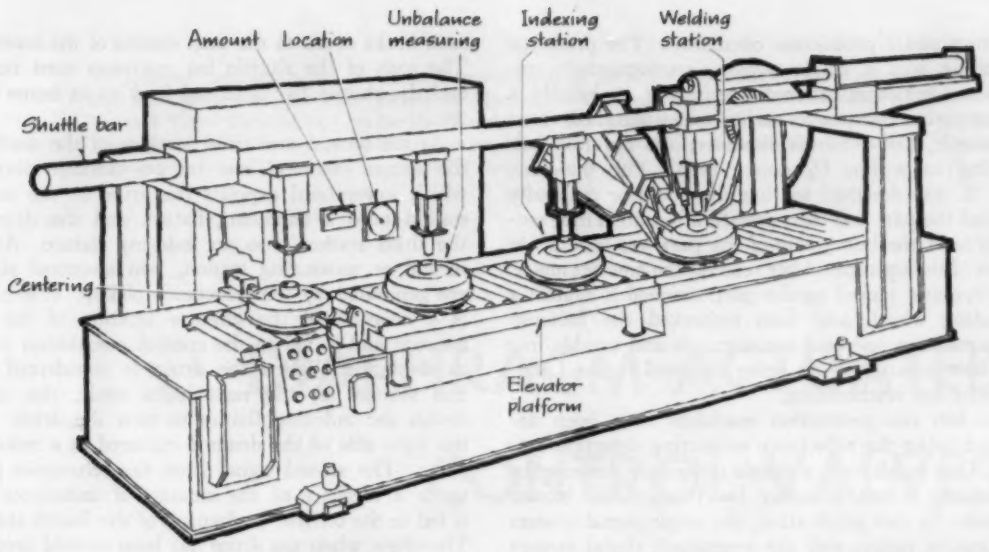


Fig. 3—Drawing shows a four-station production machine that was built to statically balance brake drum assemblies using the electromagnetic detection method. Flow path of drums is from left to right. The first station centers each drum under the shuttle bar transfer mechanism. The amount and angle of unbalance is measured at the second station. The angle unbalance signal generated at the second station is then fed to the third station where the drum is rotated to the proper position for correction of unbalance at the fourth station. The amount of unbalance signal, generated at the second station, controls the length of metal strip welded to the drum at the fourth station to correct the unbalance.

ance in automobile wheel and tire assemblies without spinning them. As part of a continuous roller conveyor line, this machine would load an assembly, measure its unbalance, ink-stamp the amount on the inside rim at the point of unbalance, and unload it to the line for correction. At another point on the line, an operator would read the unbalance marking, pick up a lead weight of the size indicated, and hammer it into place.

Recently, the Laboratories have developed a new method of static unbalance detection which not only measures an unbalance in a part accurately without spinning, but also provides for correcting the unbalance automatically. An experimental model of such a machine has been built and tested with complete success, and it is capable of balancing precision parts to less than 0.01 ounce inch. Essentially, the machine consists of a frictionless air ball pivot attached to a fixture that supports the part to be balanced, *Fig.* 1. Hanging rigidly from the fixture is a 10-inch long tube whose base extends slightly into a moat of silicone fluid. This particular construction allows an unbalanced part to tilt the entire ball-fixture-tube assembly in the plane of unbalance with no difficulty. The silicone fluid acts as a damper to prevent pendulum action and brings the assembly to rest in about one to two seconds, depending upon the size of the part being balanced.

The main feature of this machine is the method by which the direction and angle of tilt of the loaded assembly, that is, the location and amount of unbalance of the part, are detected. About half way up the length of the tube is a four-pole wound stator—an electromagnet whose poles encircle the tube in equal intervals but do not restrict the tube's movement within the magnetic field. The principle of detection is based on measuring the change of magnetic reluctance between each pole face and the tube surface when an unbalanced part swings the tube to an off-center position. Combining these changes electronically produces two independent signals: One signal represents the amount of unbalance, and the other signal indicates the angular location.

This method of detecting static unbalance in a part requires no mechanical coupling between the tube and the detector components. Therefore, the unbalance measuring operation and the correction operation can be accomplished at one station, if desirable, since the same shaft that supports the air ball fixture is also free to index the part and fixture. For example, when a part is being balanced, the angular location signal can be used to index the part so that either the heavy side is moved under a drill head to remove metal or the light side is rotated under a welding gun to add metal. The corrective device then proceeds to balance the part in accordance with the magnitude of the unbalance signal from the machine.

▶ Production Machines

The Laboratories constructed a prototype balancing machine employing the electromagnetic detection method in order to evaluate performance charac-

teristics under production conditions. The prototype machine was a single station, semiautomatic unbalance indicator tailored specifically to handle a transmission rear planet carrier which weighed about 2 pounds, had a 5-inch diameter, and required balancing to within ¼ ounce inch. The machine, *Fig.* 2, was designed so that the operator manually loaded the part and then pressed a button. Three seconds later the heavy side of the part was indexed in front of the operator. After reading the amount meter, the operator picked up the part, touched it against a grinding wheel, and then rechecked the balance. The machine operated maintenance and trouble-free for four months before being returned to the Laboratories for rescheduling.

So far, two production machines have been designed using the reluctance measuring detection system. One machine is a simple unbalance detector for balancing 2-foot diameter by 1-foot wide blower wheels. In this application, the angle signal powers a location meter, and the magnitude signal powers an amount meter. Due to a low production rate, this machine did not include an automatic indexing feature.

The second machine employing the detection system is an automatic model designed to balance brake drum assemblies. This machine, *Fig.* 3, contains four stations. Brake drums are conveyed to the first station of the machine where each assembly is halted against a stop. Then, two pneumatic cylinders on each side of the drum are actuated and center the drum under the first of four pneumatic cylinders mounted on an overhead shuttle bar. When the machine is ready to index, the rods of the cylinders are actuated simultaneously. Each rod enters the hub opening in a drum. A pneumatic cylinder then causes the shuttle bar to move laterally, indexing each brake drum to the next station of the machine. The rods of the shuttle bar cylinders then retract, and the shuttle bar is moved back to its home position.

At the second and third stations of the machine, the drums come to rest on an elevator platform which lowers and deposits the drum at the second station onto a balancing fixture and the drum at the third station onto an indexing fixture. At the second or measuring station, two electrical signals are generated by the reluctance pickup. One signal is a measure of the angular location of the unbalance and is fed to the control mechanism of the third station. When the drum is transferred into this station on the next index cycle, the signal causes the indexing fixture to turn the drum until the light side of the drum is centered at a reference point. The second signal from the reluctance pickup is a measure of the amount of unbalance and is fed to the control mechanism of the fourth station. Therefore, when the drum has been rotated properly at the third station and then transferred into the fourth station, the amount signal causes the control mechanism of the welding station to automatically meter, preform, cut off, position, and weld the correct length of metal strip to the drum to correct the unbalance.

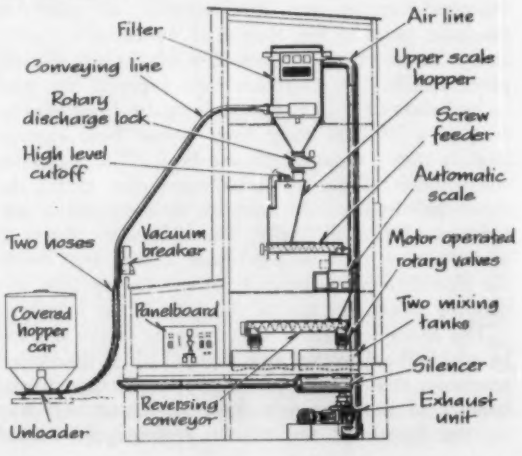
After the unbalance in the brake drum has been corrected, the shuttle bar indexes the drum onto a conveyor for movement to other operations. It will be noticed that the measuring of unbalance and the indexing of the drum occurs at two different stations while the experimental machine accomplished both operations at one station. The two operations were placed at separate stations on the production machine in order to reduce the cycle time per station and permit higher output from the machine.

pneumatic system unloads bulk clay

APPROXIMATELY 50,000 tons of kaolin, a pure white clay, are used each year in the manufacture of paper at the various mills of the New York & Pennsylvania Co. Until recently, this material was received in car-load shipments consisting of 600 bags, each containing 100 pounds of clay. In addition to requiring a full day to manually unload each car, the unloading operation often resulted in a loss of material through broken bags, created a dust problem, and presented opportunities for contamination of the material.

To overcome these difficulties, the company has installed an automatic handling system which unloads clay from covered hopper cars and delivers it to a separation filter by means of a pneumatic system. From this point, the material is automatically metered into clay preparation equipment.

As shown in the sketch, clay is delivered to the plant in covered hopper cars which hold 50 tons of material divided into two sections. A dual-feed unloader is attached to two gates on the bottom of the car, and air and output conveying lines are attached. Material drops by gravity through the gates into the unloader and is carried by air to the separation filter on the top floor of the preparation building. The filter causes the clay particles to drop out of the air stream and allows the air to flow to an exhauster unit which provides the vacuum for the system. The pneumatic conveying system, designed and built by Fuller Co., enables one operator to unload 25 tons of bulk clay an hour.



To increase uniformity of usage and understanding of terms for control valve parts and functions, the American Society of Mechanical Engineers has a Subcommittee on Control Valve Terminology under its Instruments and Regulators Division Terminology Committee. Information in this data sheet is drawn from the report of the Subcommittee which was presented as ASME Paper Number 59-A-322.

DIAPHRAGM ACTUATED CONTROL VALVES

This terminology applies to the physical and operating characteristics of diaphragm actuated, rising plug types of control valves suitable for use as final control elements in automatic control systems. The terms are intended to apply to the complete control valve including the actuator; there is no intention of recommending their use for other valve types at this time.

The terminology presented is the result of surveys of technical papers, manufacturers' literature, and users' specifications. The terms have been selected on the basis of preferred current usage and clarity. New terms have been avoided except where existing terms are inadequate or would result in ambiguity.

▸ Valve body assembly

An assembly of a body, bonnet assembly, bottom flange and trim elements. The trim includes a valve plug which opens, shuts, or partially obstructs one or more ports.

Valve body: A housing, for internal valve parts, having inlet and outlet flow connections.

Several common body arrangements are employed:

Single-ported means one port and one valve plug.

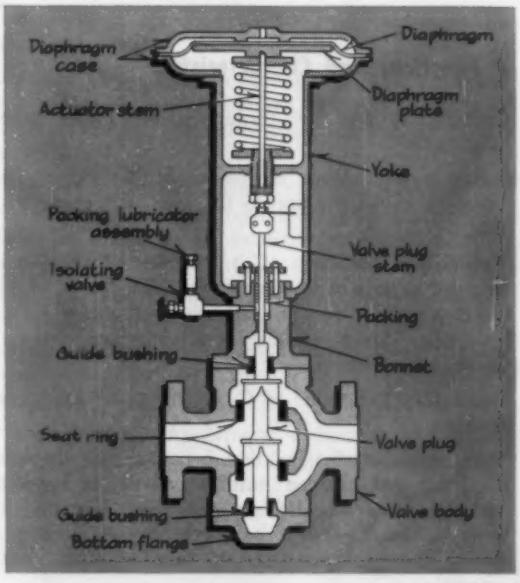
Double-ported means two ports and one valve plug.

Two-way means two flow connections—one inlet and one outlet.

Three-way means three flow connections—two inlets with one outlet, or one inlet and two outlets.

Bonnet assembly: An assembly including the part through which a valve plug stem moves and a means for sealing against leakage along the stem. It usually provides a means for mounting the actuator.

Sealing against leakage may be accomplished by packing or a bellows. A bonnet assembly may include a packing lubricator assembly with or without isolating valve. Radiation fins or an extension bonnet may be used to maintain a temperature differential between the valve body and sealing means.



Bottom flange: A part which closes a valve body opening opposite the bonnet assembly or in a three-way valve may provide an additional flow connection. It may include a guide bushing and, in a three-way valve, may also include a seat.

Trim elements:

Seat ring: A separate piece inserted in a valve body to form a valve body port.

Seat: That portion of a seat ring or valve body which a valve plug contacts for closure.

Valve plug: A movable part which provides a variable restriction in a port.

Valve plug guide: That portion of a valve plug which aligns its movement in either a seat ring, bonnet, bottom flange, or any two of these.

Valve plug stem: A rod extending through the bonnet assembly to permit positioning the valve plug.

Guide bushing: A bushing in a bonnet, bottom flange, or body to align the movement of a valve plug with a seat ring.

Top and port guided is a design in which the valve plug is aligned by a guide in the bonnet or body and a guide in the body port.

Port guided is a design in which the valve plug is aligned by the body port or ports only.

Top and bottom guided is a design in which the valve plug is aligned by guides in the body or guides in the bonnet and bottom flange.

Top guided is a design in which the valve plug is aligned by a single guide in the body adjacent to the bonnet or in the bonnet.

Stem guided is a special case of top guided in which the valve plug is aligned by a guide acting on the valve plug stem.

▸ Diaphragm actuator

A fluid pressure operated, spring or fluid pressure opposed, diaphragm assembly for positioning the actuator stem in relation to the operating fluid pressure or pressures.

Diaphragm: A flexible pressure responsive element which transmits force to the diaphragm plate and actuator stem.

Diaphragm plate: A plate concentric with the diaphragm for transmitting force to the actuator stem.

Diaphragm case: A housing consisting of top and bottom sections used for supporting a diaphragm and establishing one or two pressure chambers.

Actuator stem: A rod-like extension of the diaphragm plate to permit convenient external connection.

Yoke: A structure by which the diaphragm case assembly is supported rigidly on the bonnet assembly.

▸ Functions and Characteristics

Capacity: Rate of flow through a valve under stated conditions.

Rated travel: Linear movement of the valve plug from the closed position to the rated full open position.

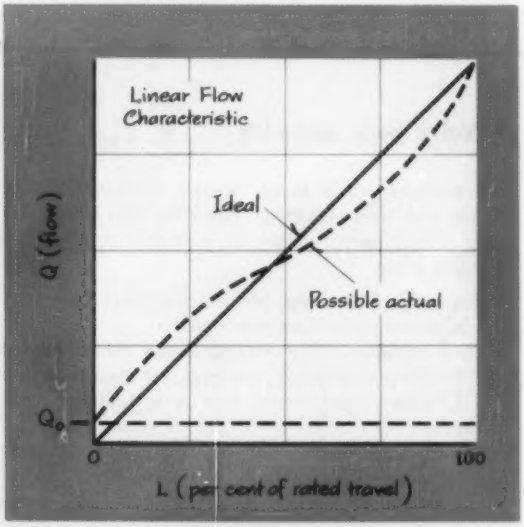
Valve flow coefficient (C_V): Number of U. S. gallons per minute of 60 F water that will flow through a valve with a one psi pressure drop under stated conditions. Stated conditions include pressure and per cent rated travel.

Rated C_V: The value of C_V at the rated full open position.

Flow characteristic: Relation between flow through the valve and per cent rated travel as the latter is varied from zero to 100 per cent. This is a general term. It should always be designated as either inherent flow characteristic or installed flow characteristic.

Inherent flow characteristic: Flow characteristic when constant pressure drop is maintained across valve.

Linear flow characteristic: An inherent flow characteristic which can be represented ideally by a straight line on a rectangular plot of flow versus per cent rated travel. Mathematically:

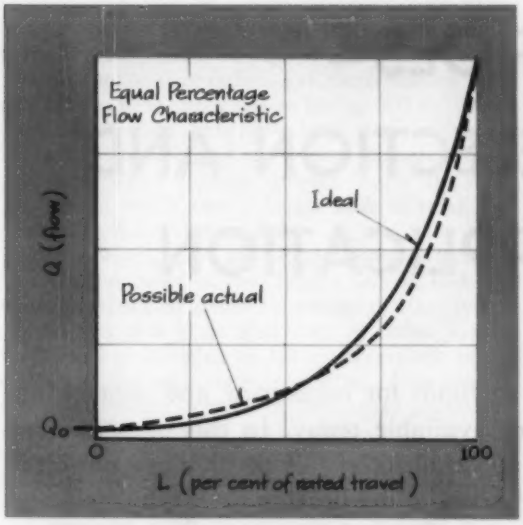


$$Q = mL + Q_0$$

where Q = flow; L = per cent rated travel; m =

a proportionality factor, the ratio of increment of flow to unit increment of travel; and Q_0 = value of Q corresponding to L = zero. Ideally, equal increments of travel yield equal increments of flow at constant pressure drop.

Equal percentage flow characteristic: An inherent flow characteristic which, for equal increments of rated travel, will ideally give equal percentage changes of the existing flow. Mathematically:



$$\frac{dQ}{Q} = ndL \quad \text{or} \quad Q = Q_0 e^{nL}$$

where symbols are the same as for linear flow characteristics, with n = a proportionality constant and e = 2.718.

Quick opening: An inherent flow characteristic in which there is maximum flow with minimum travel.

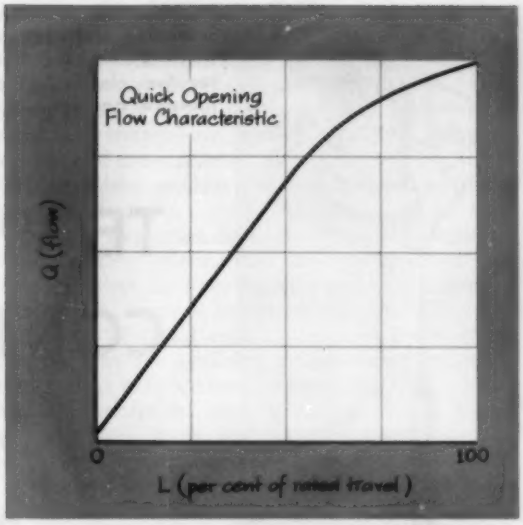
Installed flow characteristic: Flow characteristic when pressure drop across valve varies as dictated by flow and related conditions in system in which valve is installed.

Unit sensitivity: The per cent increase in existing flow for an increase in movement of one per cent of rated travel at a stated operating point. Mathematically:

$$Sv = \frac{Q_2 - Q_1}{Q_1} \times 100$$

where S_V = unit sensitivity, Q_1 = flow before travel change, and Q_2 = flow after increasing travel by one per cent of rated travel.

Inherent rangeability: Ratio of maximum to minimum flow within which the deviation from the specified inherent flow characteristic does not exceed some stated limits.



Leakage: Quantity of fluid passing through an assembled valve when valve is in fully closed position under stated closure forces, with pressure differential and temperature as specified. Leakage is commonly expressed as a percentage of capacity at rated travel or as a cumulative quantity over a specified time.

Dead band: The amount the diaphragm pressure can be varied without initiating valve plug motion.

Inherent diaphragm pressure range: The high and low values of pressure applied to the diaphragm to produce rated plug travel with atmospheric pressure in the valve body.

Installed diaphragm pressure range: The high and low values of pressure applied to the diaphragm to produce rated travel with stated conditions in the valve body.

Diaphragm pressure span: Difference between the high and low values of the diaphragm pressure range. May be stated as an inherent or installed characteristic.

Normally open: Applying to a normally open control valve assembly, one which opens when the diaphragm pressure is reduced to atmospheric. In a three-way valve the normally open port must be specified.

Normally closed: Applying to a normally closed control valve assembly, one which closes when the diaphragm pressure is reduced to atmospheric. In a three-way valve the normally open port must be specified.

Static unbalance: The net force produced on the valve plug in its closed position by the fluid pressure acting upon it.

Dynamic unbalance: The net force produced on the valve plug in any stated open position by the fluid forces acting upon it.

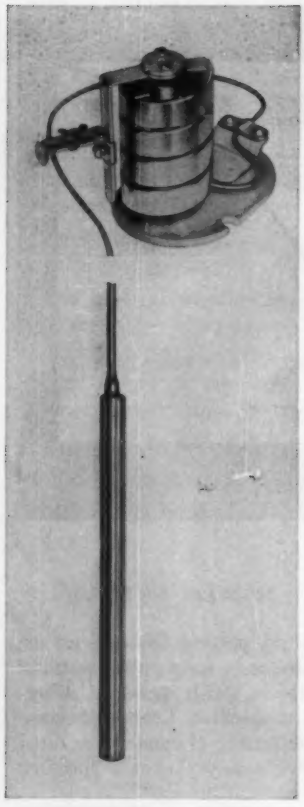


Fig. 1—Filled measurement systems generally are the most inexpensive way of measuring and controlling temperature. They usually consist of a sensing bulb which is connected through capillary tubing to an expansible pressure or volume sensitive element. The transmitting media used in filled systems are vapor pressure, gas pressure, mercury, or liquid.

TEMPERATURE CONTROLS— SELECTION AND APPLICATION

Many different methods for measuring and controlling temperatures are available today. In this presentation the basic types and characteristics of each are outlined along with their areas of application.

By **HAROLD G. PAYNE**, Manager, Measurements Group, Foxboro Co., Foxboro, Mass.

OUT OF NEARLY an infinite range of temperature measurement and control equipment and application fields, this article will be confined to the measurement of temperature by filled thermal systems, resistance bulbs, and thermocouples. It will also cover positioning of the final operator by controllers of the pneumatic, electric, and electronic types used on industrial processes—both batch and continuous—where the final control operator is physically separated from the measuring and controlling instruments.

Filled Measurement Systems

Filled systems are derivations of the earliest thermometers and generally consist of a sensing bulb connected through capillary tubing to a bourdon or other expansible metallic pressure or volume sensitive element, *Fig.* 1. Application specifications of the various filled system types are given in TABLE 1.

Vapor Pressure Systems. These systems are the the least costly of all systems because they are the simplest mechanically, a point which contributes to their customarily longer life. They are inherently accurate for they follow natural physical laws and require no compensation for ambient temperature effects. They are generally the fastest responding systems. Since they follow the vapor pressure curves of common fluids, their charts and dials, *Fig.* 2, have wider spaced temperature increments at the high end of the range. This results in increased readability and sensitivity in the normal operating area of the range. Very narrow spans in the liquid hydrogen region are practical at some increase in cost for barometric compensation.

Due to a change in state from liquid to vapor in the tubing and bourdon element as the bulb temperature drops below ambient temperature, measurements at or crossing ambient temperature are usually not recommended. Special filling techniques and fluids can minimize possible undesirable effects but usually at the sacrifice of performance and cost.

The usual nonlinear output of vapor systems requires specifically prepared charts which make it awkward to combine multiple measurements on one chart. These thermal systems, where bulb temperatures are above ambient, have the least available over-range capability of all the filled systems. Exact

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

limits are published for each range. Thermal systems for temperature measurement far below ambient are protected against over-range in shipment; protection to boiling water temperatures is possible in some instances.

Gas Pressure Systems. Second only to vapor pressure in mechanical simplicity and cost, gas systems can measure the widest range of temperatures of all filled systems. Even with the moderate extra charge for a gas thermometer to measure above 1000 F, the total cost of a temperature measuring system can stay far under that of a thermocouple or resistance thermometer system and is more naturally adaptable to continuous pneumatic control systems.

In conventional recorders, gas thermometers perform best as wide range devices having 300 to 1000 F spans. With their relatively large bulb volumes, they may be used to measure average temperatures of gaseous products flowing through large ducts or furnaces, in which case a longer bulb of small diameter, *Fig.* 3, is recommended.

Their nontoxic inert gas filling (nitrogen, helium, etc.) is often preferred over liquids such as mercury or hydrocarbons contained in systems of other types. Gas systems of a given span may be rather simply recalibrated to a higher or lower temperature range as long as the span remains constant. Gas systems offer the greatest amount of over-range protection of all the filled systems.

Conventional recorder-controller type gas thermometers are not recommended for spans less than 200 or 300 F. However, pneumatic temperature transmitters, gas filled and operating on the force balance principle, are commonly made in spans as narrow as 50 F. The conventional recorder system usually requires a large bulb which, even if it can be accommodated by the line or vessel, presents a large target for fast flowing fluids and often requires larger, more expensive protection wells. Gas systems are the most difficult to compensate accurately for ambient temperature changes due in part to the fact that gas density in the instrument element increases with bulb temperature, hence requiring a nonuniform rate of compensation. A large bulb is commonly used to reduce residual ambient temperature error to acceptable limits.

Mercury Expansion Systems. In the region above 600 F, mercury systems offer the smallest filled system bulb sizes. In force balance temperature transmitter form, mercury bulb sizes approach the small dimensions of liquid expansion system bulbs. Mercury systems are available in the widest range of span widths and common temperatures, and, therefore, are perhaps the most "universal" system. However, standardization on any one system seldom results in best performance at lowest cost.

On the other hand, mercury is harmful to some industrial products and is toxic. This may dictate the use of a thermometer well where it would otherwise not be required. The best fitting bulbs and wells still increase measurement lags 5 or 10 times that of bare bulb systems. Conventional mercury systems cannot match the speed of response of vapor systems. There are limitations on bulb-to-instrument elevation differences because of the density of mercury. Bulb sizes vary with span width and are larger in diameter than liquid or vapor system bulbs.

Liquid Expansion Systems. These systems are available in narrower spans and smaller bulb sizes than other filled systems. Uniform calibration, applicability to measurement of ambient temperature range, and small bulb size have made liquid systems the most common for the vast amount of fluid transmission and storage temperature applications. Class

TABLE 1—Application Data for Filled Measurement Systems

Characteristic	Vapor Pressure	Gas Pressure	Mercury Expansion	Liquid Expansion
SAMA Class	IIA, B, C, D	IIIB	VA, VB	IA, IB
Temperature Limits, F	−300 to 600[1]	−450 to 1400	−38 to 1200	−300 to 600
Minimum Span, F	70[1]	200[6]	100[6]	40
Maximum Span, F	400	1000	1200	600
Limits Of Overrange	IIA, C, D (50 F above top scale temp.) IIB (120 or 212 F)	1200 F[7]	100-200% of span	50-100% of span
Tubing Length, max.[2]	150 ft	100 ft	VA-100 ft VB-50 ft	IA-100 ft IB-20 ft
Bulb Size, maximum	6 x ⅝	10 x ⅞	6 x ⅝	6 x ⅜
minimum	2 x ⅜	6 x ⅝[4]	3 x ½[4]	3 x ¼
63% Time Constant[3], sec.	2	2-8[4]	2-6[5]	6
Cost	Low	Medium Low	Medium High	High
Calibration	Nonuniform[5]	Uniform	Uniform	Uniform

1. Spans as narrow as 20F are possible under certain application conditions, particularly very low temperatures. Minimum temperature of −425F possible with special construction.

2. Longer lengths possible, but unwieldy bulb sizes or poor ambient temperature compensation usually result.

3. Time for temperature to reach 63 per cent recovery constant of a step change for bulbs immersed in well agitated liquid baths. Short tubing lengths and minimum bulb diameters are required to obtain these minimum figures.

4. Lowest value generally attainable only with force balance pneumatic transmitters. These instruments have bulbs as small as 6 x ⅝ (gas systems) and 3 x ⅝ (mercury systems).

5. Uniform motion or output with temperature may be accomplished for certain ranges by mechanical means.

6. Minimum gas and mercury system span for force balance pneumatic transmitters is 50F.

7. Reduce to 250F for narrowest spans.

IA fully compensated system readings are free of bulb immersion errors and are recommended for measuring temperatures of deep vessels with varying liquid depths. Class IB case compensated systems are calibrated for a specific immersion. A change in immersion will result in an error. Once somewhat susceptible to rough handling, Class IA system capillary tubing is now available within a smooth $\frac{1}{8}$-inch diameter stainless steel armor for maximum protection.

Fully compensated liquid systems are more expensive than vapor or gas systems because they are more complex and require more time to build. Bulb size varies with span width. Response times are greater than vapor systems.

Extending Flexibility

Pneumatic transmission, *Fig.* 4, has given filled systems even wider application. The transmitter has lengthened the practical maximum distance to point of measurement from 100 to 500 or more feet depending on allowable transmission lag. It has made possible gas and mercury systems having narrower spans and smaller bulbs. The possibility of damage to thermal system capillary is reduced and consequently out-of-service time and expense is also reduced. Pneumatic transmission also allows greater flexibility of control loop components because standardized recorders and control stations can receive one or more signals from many variables.

It should be recognized that pneumatic transmission adds another mechanical component with its minor inaccuracies to the control loop. The selection of a transmission system in preference to the direct mechanical filled system was originally based on transmission distance. Today, the more linear and faster responding pneumatic temperature transmitter may frequently be found in use only 10 to 50 feet away from its receiver instrument. Faster response and the greater flexibility of the component-part common signal control loop often outweigh the added cost of transmission.

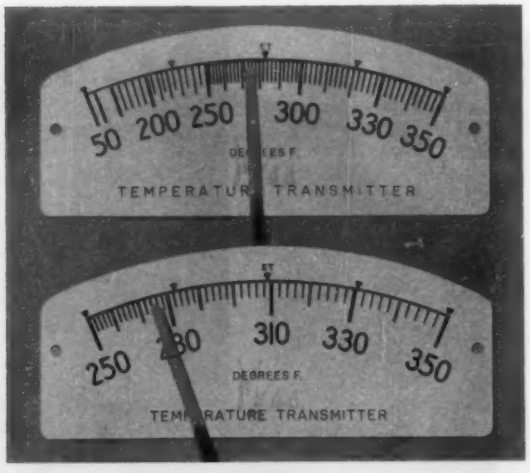


Fig. 2—Vapor pressure systems follow vapor pressure curves of common fluids, and their indicating charts and dials have wider spaced temperature increments at the high end of a range. The upper scale of this two-scale indicating temperature transmitter covers the full range of the vapor pressure system, and the lower scale covers the operating range of the instrument.

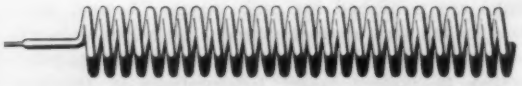


Fig. 3—Since gas pressure systems require large sensing bulb volumes, this form of coiled capillary bulb is often used to obtain the necessary volume. These systems are useful in measuring average temperatures of gaseous products in ducts or ovens.

Electrical Measurement Systems

Electrical measurement by thermocouple or resistance element has been historically the standard procedure in metal, power, and refining industries as the filled system has been in the food, paper, textile, and other industries. More recently, the historic lines are disappearing.

For temperature control system measurements TABLE 2 lists comparative characteristics. Thermocouple measurement has been so thoroughly detailed for years that only the temperature and span limits are tabulated.

Thermocouple Systems. The following is written to apply to thermocouple measurements using null balance instruments. The lower-cost deflection type of millivolt instruments do not have the power necessary to properly operate control mechanisms other than simple *On-Off* electric contact types.

The thermocouple undoubtedly offers the most versatile way to measure and, more recently, to control temperature. Each component of the measuring system is a separate and individually replaceable item, i.e., couple, lead or extension wire, and emf instrument. One type of couple, notably the iron-constantan, can measure an extremely broad range of temperatures although not necessarily with the highest or equal accuracy. Both the couple and the emf instrument can be easily and separately checked for calibration. Range changing is relatively inexpensive and simple.

One of the principal advantages of thermocouple measurement is that very long distances are possible between the couple and the instrument. Distances well over 2000 feet are practical, the only limitation being that the total circuit resistance must be kept below a value which might appreciably affect the emf received at the instrument.

Thermocouples generally offer the fastest bare bulb response of the measuring systems discussed. However, for use bare in liquids, the metallic sheathed type of couple is necessary. Since couples are so widely used with protection wells in industry,

this basic attribute takes on less importance.

Lags can be greatly reduced by using sheathed couples bare where possible. A newer construction allows sheath materials of Inconel and Monel alloys as well as a wide variety of stainless steels. Outside diameters of sheaths, *Fig.* 5*a*, may be as small as 1/16 inch.

The degree of maintenance required by thermocouple systems is governed mainly by the type of null balance millivolt instrument involved. Maintenance has been continuously reduced as the changes from galvanometer to slide-wire-electronic to capacitor-electronic to solid state devices have occurred. Previous to the latest types, maintenance was considerably higher than that required by filled system measurement devices. Today, maintenance of thermocouple systems need not be especially greater than for mechanical thermometers.

The thermocouple has often been accepted as an authoritative standard of accuracy far beyond its true value. For temperatures below 1500F, it is seldom the most accurate measurement (see limits of errors shown in TABLE 2). Added to these inaccuracies are those of the receiving instrument which can be reasonably low, usually plus or minus ¼ per cent of millivoltage span.

Unfortunately, one of the greatest attributes of the thermocouple system—that of multiple point measurement with one instrument by means of a switching arrangement—is of little value for automatic control purposes. With slow changing temperatures and nonexacting *On-Off* control, up to six points may be handled by one instrument.

Thermocouples may be paralleled or used in series to obtain average temperatures in larger gaseous streams, although failure of any one couple will affect the net emf and hence the total measurement. Recommendations of manufacturers should be followed closely when using this multiple couple technique to avoid potentially large errors from the cold junction and possible wide tolerances of each component of the network.

More customary, single couple applications allow point temperature measurement, for only the tip (hot junction) of the couple is sensitive. The cold junction, usually remote from the couple and located in the emf instrument for automatic compensation purposes, must be held at a reasonably constant temperature. The instrument sees only the difference in emf generated by the two junctions. Out-

TABLE 2—Application Data for Electrical Measurement Systems

Thermocouples	Symbols	Temperature Limits[1], F	Maximum Overrange Temp., F	Minimum Span in Specified Range[2], F					Max. Span
				−100 to 200	200 to 500	500 to 1000	1000 to 2000	2000 to 3500	
Copper-Constantan	T	−300 to 650	1100	250	200	160	—	—	A[3]
Iron-Constantan	J	−300 to 1400	1800	200	175	160	150	—	A
Chromel-Alumel	K	−300 to 2000	2200	250	225	220	220	—	A
Platinum/Rhodium-Platinum	R,S	32 to 2650	3100	—	900	800	700	650	A
Resistance Bulbs									
Nickel	—	−320 to 600	660	5	5	5	—	—	B[4]
Platinum	—	−420 to 1650	1800	120	120	120	120	—	B
Copper	—	−320 to 250	300	200	200	—	—	—	B

1. Upper temperature limits vary depending on construction and wire size. Smaller gage thermocouples are more sensitive but deteriorate faster at higher temperatures.

2. Approximate temperature change necessary to develop about 5 millivolts in the specified range. Substantially narrower spans will apply with the less common minimum null-balance instruments with a 1 millivolt span.

3. Maximum span "A" governed only by applicable temperature limits.

4. Maximum span "B" generally governed by measuring instruments within temperature limits listed. The use of resistance thermometers for wide span application (greater than 200 F) generally defeats the superior accuracy characteristic for which resistance measurement is most often selected.

Limits of Error of Thermocouples and Extension Wires

Thermocouples	Temperature Range, F	Standard Limits of Error	Extension Wire	Temperature Range, F	Standard Limits of Error, F
Copper-Constantan	−150 to −75	±2%	Copper-Constantan	−75 to 200	±1½
	−75 to 200	±1½F			
	200 to 600	±¾%			
Iron-Constantan	0 to 530	±4F	Iron-Constantan	0 to 400	±4
	530 to 1400	±¾%			
Chromel-Alumel	0 to 530	±4F	Iron-Cupronel	75 to 400	±6
	530 to 2300	±¾%	Chromel-Alumel		
Platinum/Rhodium-Platinum	0 to 1000	±5F	Copper-Alloy	75 to 400	±12
	1000 to 2700	±½%			

door instrument installations, therefore, present an ambient temperature regulation problem.

Resistance Measurement Systems. Nickel, platinum, and copper element resistance bulbs, *Fig. 5b, c, d, e,* are all widely used in industrial applications. While platinum resistance bulbs are used as laboratory standards with certified accuracies to within 0.1F, industrial platinum elements generally carry accuracies of 0.5F or 0.25 per cent of reading comparable with nickel bulbs.

The resistance of nickel bulbs is customarily trimmed by external "padding" resistors after winding, stress relieving, and resistance checking. This practice allows any desired degree of exactness, both in bringing an individual bulb to a predetermined curve and in making bulbs readily interchangeable without loss of accuracy. Nickel resistance bulbs are made to follow a true exponential curve which mates nicely with the characteristics of null balance bridge instruments. This results in uniform instrument calibration with temperature.

It also allows two standard nickel element bulbs to be used for temperature difference measurement, regardless of the actual operating temperature. This combines with the very narrow spans available, such as 5F, to allow very exacting temperature difference control.

The lower cost of copper bulbs and their linear coefficient of resistance change to temperature have made them popular with certain manufacturers. Their greatest limitation is their maximum temperature of 300F.

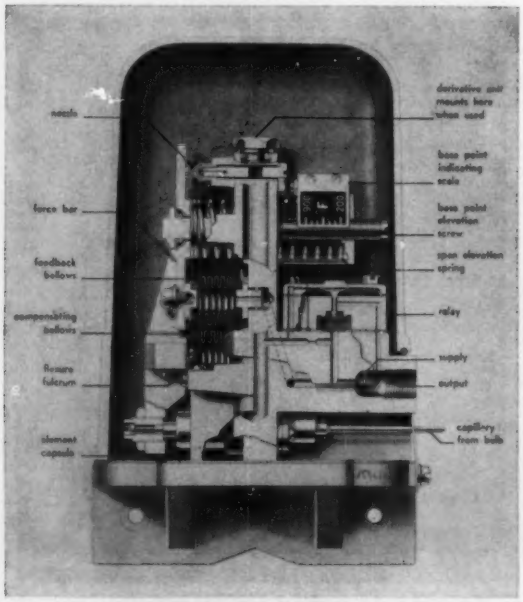
Platinum bulbs are usually the most expensive due in part to their method of manufacture which is a carry-over from laboratory bulb techniques. Platinum bulbs are used to measure much lower and higher temperatures than nickel or copper. They are common replacements for thermocouples for more precise measurement of temperatures in the 600 to 1500F region.

Tubular shape resistance bulbs are available in both tip and side-wall sensitive types for use in liquids, and are generally encased in stainless steel. They are also available in flat and formable construction for surface temperature measurements. Specialized forms provide roll surface measurement. The common tube type is equipped with a well and head assembly similar to thermocouples or a completely sealed waterproof head.

While averaging temperature measurements are possible with bulbs of special construction or a number of bulbs in parallel, the more economical way is with thermocouples and filled systems. Resistance bulb systems for fluid measurements under pressure generally cost two to twenty times that of an equivalent thermocouple assembly.

One distinct disadvantage of the resistance bulb, as compared with the thermocouple, is the lack of interchangeability from one manufacturer to another.

Fig. 4—Filled measurement systems are usually limited to applications where the point of measurement is less than 150 feet from the control instrument. This application range can be extended to 500 feet or more by installing a pneumatic transmitter in the system. A typical force balance temperature transmitter for a gas pressure system is shown.



Comparison of Systems

The substantially lower cost certainly justifies consideration of the filled system for temperature measurements below 1200F. However, the final selection of a measurement method must take account of the over-all process control requirement. Mechanical or pneumatically transmitted temperature measurements offer these advantages, among others, over electrical measuring systems: Lower cost, up to four continuous separate records on one chart, no explosion hazard, less technical maintenance help required, and over-all greater dependability of direct-connected types.

Disadvantages of mechanical or pneumatic systems in comparison to electrical systems include: Less sensitivity, less accuracy (depending somewhat on span), switching of several measurement points not practical, the usual limitation of 500 feet or less from the measuring element to the controller, replacement of the complete filled system in the event of bulb or tubing failure, slower response of control loop, and inability to measure temperatures over 1200 to 1400F.

TABLE 3 summarizes some of the advantages of various forms of temperature measurement. Each temperature measurement and control problem deserves its own evaluation, however, and judicious selection must inevitably draw on the designer's practical experience.

Control Applications

The five common control modes or actions available through pneumatic, electric or electronic control mechanisms are: *On-Off,* proportional, propor-

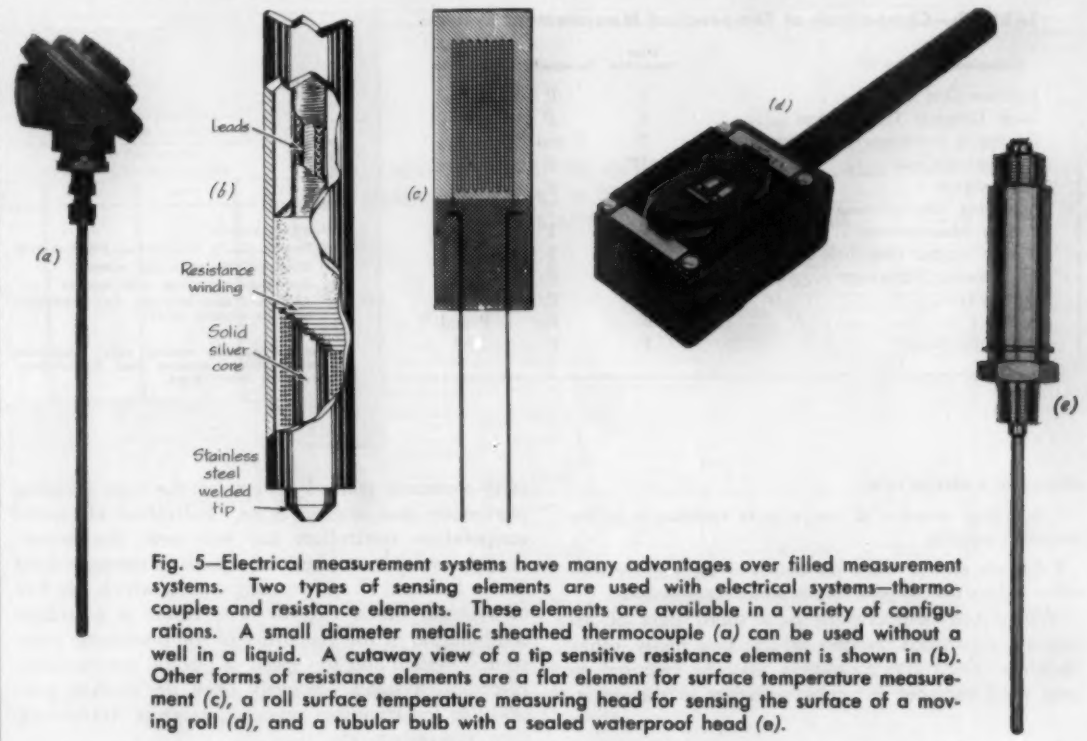


Fig. 5—Electrical measurement systems have many advantages over filled measurement systems. Two types of sensing elements are used with electrical systems—thermocouples and resistance elements. These elements are available in a variety of configurations. A small diameter metallic sheathed thermocouple *(a)* can be used without a well in a liquid. A cutaway view of a tip sensitive resistance element is shown in *(b)*. Other forms of resistance elements are a flat element for surface temperature measurement *(c)*, a roll surface temperature measuring head for sensing the surface of a moving roll *(d)*, and a tubular bulb with a sealed waterproof head *(e)*.

tional plus reset, proportional plus derivative, and proportional plus reset plus derivative. All of these are variations of proportional control. While the proper mode for a given temperature control problem could be any one of them, *On-Off* and proportional plus reset plus derivative are most frequently used.

Many excellent papers and books have been written on the measurement, set-point, and valve-position relationship of the various modes. It is needless to repeat them. References to a few are contained in the bibliography.

For the very simple control problem where apparatus of large capacity, such as an open tank, is heated directly by steam injection, *On-Off* control is practical. With *On-Off* control, temperature will cycle to an extent which depends on the nature of the process. If the magnitude of the cycle is tolerable from both the product temperature and the heat supply standpoints, *On-Off* or very narrow band proportional control can be used. There are many areas, such as kilns, driers, simple kettles, and tanks, where this type of control is acceptable at noticeable savings in cost. Electric types particularly show material differences in cost between *On-Off* and the more complex modes of control.

When other than this simplest control mode is necessary, the final selection may well jump all the way to proportional plus reset plus derivative. Reset action compensates for load changes as more or less product is put through the process. Derivative action compensates for lags in the control system loop or process. Common lags are those from a thermometer well, long transmission distances, and the heating medium not being in intimate contact with the measured variable.

Very fast low-capacity processes, such as small tube-type heat exchangers, will not require derivative but will need reset action. In some cases, derivative may introduce distinctly undesirable effects. There are cases where even the most sensitive and rapidly responding equipment may not keep up to the process rate-of-change potential. In these instances, the fastest sensing device possible must be carefully located at the most representative measurement location, and its output must be detected by close coupled control equipment to position a rapidly stroking final operator. No temperature control system can function properly unless the sensing bulb is in a nonstagnant location which is truly representative of the temperature to be controlled.

There are certain process control problems which cannot be satisfactorily solved by a single control unit. Problems of this nature gave rise to the development of:

1. Duplex controllers where two separate control mechanisms and final operators are actuated by one measurement.

2. Cam-set controllers where a predetermined time-temperature schedule is represented by a rotating cam to continuously adjust the control point setting.

3. Ratio controllers where one controlled variable has its control point set in a constant ratio to an uncontrolled vari-

TABLE 3—Comparison of Temperature Measurement Systems

Comparison Factors	Most Favorable	Intermediate	Least Favorable
Purchase Cost	F	P	R
Long Distance Transmission	E	P	F
Change or Replacement of Components	T	E and P	F
Installation Costs	E*	F	P
Maintenance	F	P	E
Averaging Measurement	F	T	R
Surface Measurement	R	T	F
Time Constant (bare bulb and no well)	T	F	R
Temperature Difference	R	F	T
Sensitivity	E	P	F
Accuracy	R	F	P and T
Operating Costs	F	E	P

KEY

F—Filled system
P—Pneumatically transmitted filled system
T—Electrical thermocouple system
R—Electrical resistance bulb system
E—Electrical thermocouple and resistance systems equally rated

*General purpose wiring only. Explosion proof electrical systems cost considerably more than other types.

able (or in a relation to it).

4. Automatic selection of one or more variables to be the controlled variable.

5. Cascade control where the output of the primary controller adjusts the set point of the secondary controller.

Where one temperature is a small part of an over-all controlled process which has many other variables, electronic computers may be required to keep each variable in proper relation to the other.

▶ Control Systems

One of the most significant recent changes in available control systems is the addition of solid state electronic control systems to the long standing pneumatic and electric types. Individual electronic temperature controllers are not new; the breakthough comes in transmitted signals of common level and a full line of system components which are free of vacuum tubes, *Fig.* 6. The result is a unique combination of the versatility of the pneumatic component system and the speed of electric transmission. Electronic systems obviously open up exciting possibilities for complete process analyzers, computers, data processing, etc.

As the instrument industry offers two or three pneumatic transmission signal levels, so too does it have various electrical levels: 1-5 ma dc, 4-20 ma dc, 10-50 ma dc, 0.200 mv ac, etc. While this will

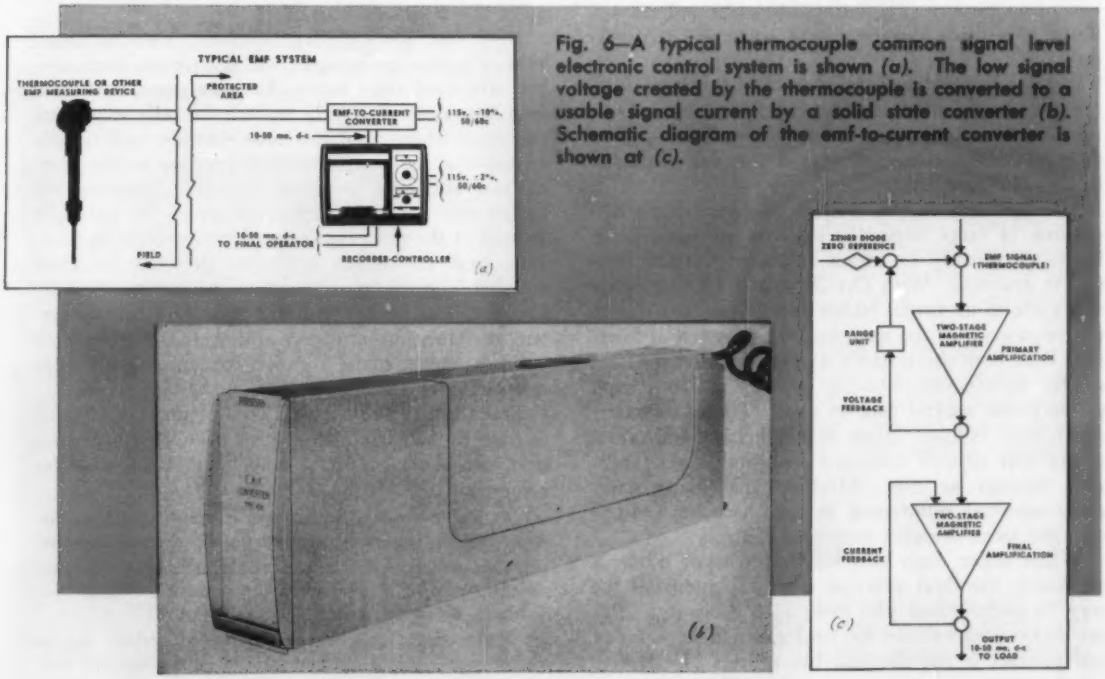


Fig. 6—A typical thermocouple common signal level electronic control system is shown *(a)*. The low signal voltage created by the thermocouple is converted to a usable signal current by a solid state converter *(b)*. Schematic diagram of the emf-to-current converter is shown at *(c)*.

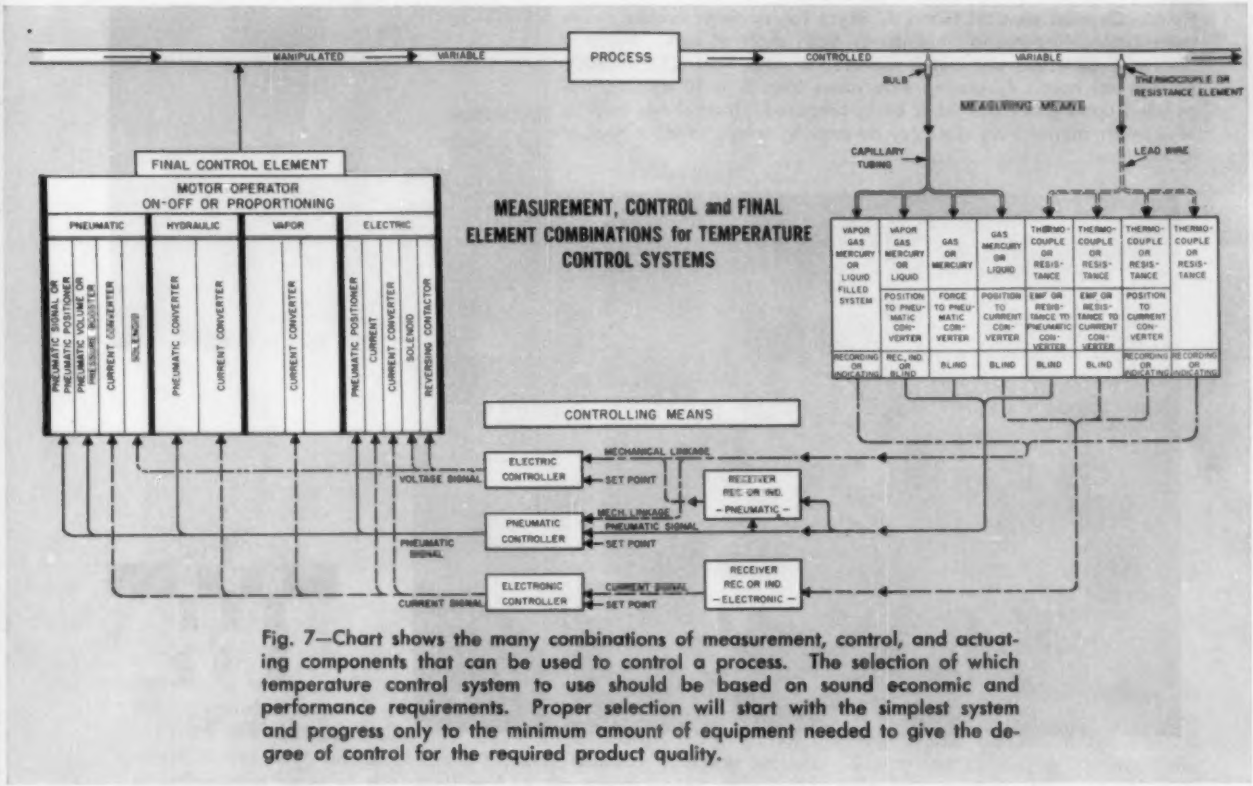


Fig. 7—Chart shows the many combinations of measurement, control, and actuating components that can be used to control a process. The selection of which temperature control system to use should be based on sound economic and performance requirements. Proper selection will start with the simplest system and progress only to the minimum amount of equipment needed to give the degree of control for the required product quality.

cause some annoyance to process designers, the improvement in process control attainable with equipment at any of these levels should outweigh this inconvenience.

The selection of a temperature control system, *Fig.* 7, should result in the least amount of equipment to give the degree of control necessary for the product quality required. However, there are also economic questions which may affect the final selection, such as:

1. Has the plant standardized on component transmission systems instead of direct measurement recorder-controllers?
2. Are operators and maintenance personnel better trained or more accustomed to electrical or to mechanical-pneumatic devices?
3. Is the cost of electrical energy less than compressed air? Is the cost of standby electrical generators less than comparable standby pneumatic equipment? Which costs less to maintain?

Proper selection will start with the simplest system and not move to more complex and expensive methods until sound economic or performance requirements so dictate. This may seem to be a needless statement, but as mentioned earlier, historic methods may be no more than historic in view of new instrument types available or gradual changes in plant requirements.

Assuming the correct mode of control has been selected, no control system will function properly unless the measurement is truly representative of the temperature to be controlled and unless the final control element is properly sized, in good working order, and capable of being positioned accurately at the rate required by the process.

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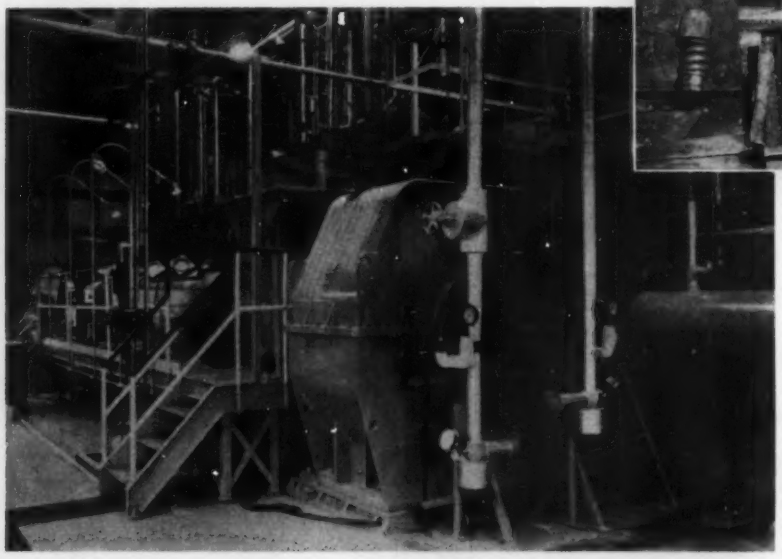

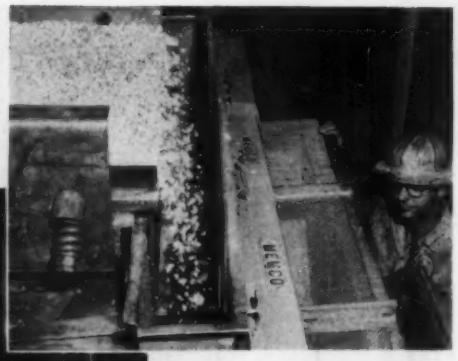

Fig. 1—Over-all view of extrusion dryer for synthetic rubber shows transmission, foreground, that drives main shaft of unit. Machine dries and pelletizes wet crumb material at rates from 6000 to 8000 pounds per hour. Processing time varies from 5 to 10 minutes, depending upon grade of rubber being prepared. Inset shows feeding of crumb material from vibratory dewatering screen to input hopper of machine.

EXTRUSION DRYING UNIT

PROCESSES SYNTHETIC RUBBER

By D. L. MATTHEWS and H. E. PHELPS

Vice President, Manufacturing
Manager, Mechanical Design & Construction
Goodrich-Gulf Chemicals Inc., Cleveland, Ohio

A CRITICAL STEP in the production of high grade synthetic rubber is the drying of wet crumb materials discharged from leaching tanks. Ideally, this process should produce a polymer that is uniformly dry, free from contaminants, and with low ash content. For example, excessive moisture, even in the form of isolated "wet spots," can lead to pigmenting difficulties where the material will resist coloration. The presence of inorganic impurities in dried polymer can make it unsuitable for electrical, certain adhesive, and other specialty uses. Also, excessive ash in the polymer can affect its cure rate, water sensitivity, and insulating properties.

An extrusion dryer developed by Goodrich-Gulf Chemicals Inc., working with National Rubber Machinery Co., promises to overcome many of the difficulties heretofore experienced with the drying process. Installed at the Institute, W. Va., plant of Goodrich-Gulf, the unit, *Fig.* 1, has been subjected to extensive operational tests. Design capacity of the machine is 6000 to 8000 pounds per hour of dried product, with cycle times of 5 to 10 minutes. The unit is self-cleaning, and uses corrosion resistant materials in critical areas.

Operational Sequence

In preparing the wet crumb, raw materials are first processed in a series of coagulation, soap conversion, and leach tanks, *Fig.* 2. From the leach tank, the crumb material passes over a vibratory

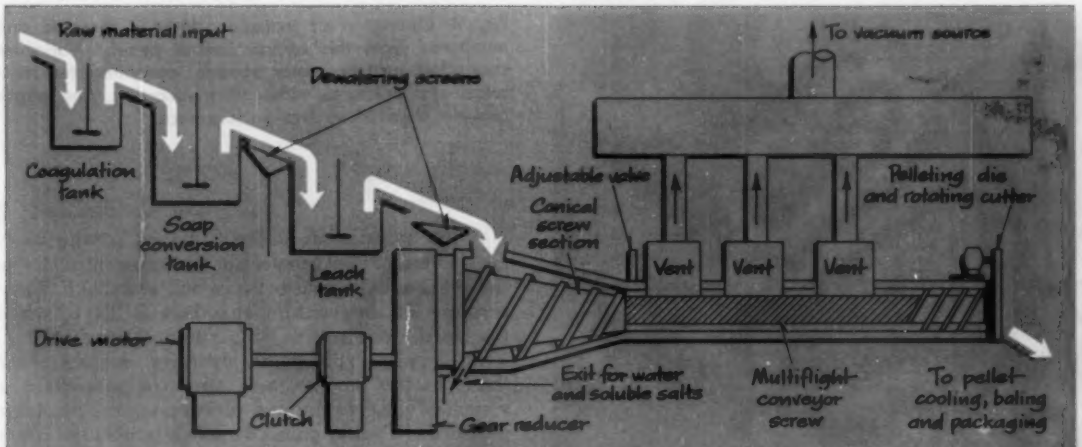

Fig. 2—Simplified diagram illustrates major steps in production of raw synthetic rubber subsequently used by processors in manufacturing finished products. Constructional features of extrusion dryer are shown in sectional view of unit.

dewatering screen and drops into the feed box of the extrusion dryer.

In the first section of this unit a rotating conical screw, 4 feet long, advances the wet crumb toward an adjustable valve at the small end of the screw. Normal clearance between the screw and its liner is about 0.040-inch on a side. The opening between the beveled bearing surface at the discharge end of the conical screw and the beveled surface of the valve is adjusted between limits of 0.015 and 0.125-inch, depending upon the type of polymer being processed.

As the wet rubber is compressed at the valve, pressure builds up and approximately 80 per cent of the water in the material is squeezed out. This water, carrying with it water soluble salts, flows through an opening in the bottom of the conical screw section. The material passing through the valve is in the form of a thin sheet.

Linked to the end of the conical screw beyond the valve is a straight, 22-foot long, multiflight screw. This rotary member acts as a conveyor to carry the rubber through a series of three vacuum chambers where additional moisture is removed. When the rubber leaves the last vacuum chamber, its moisture content is at or below the standard specification of 0.5 per cent. Vacuum in each of the chambers is held to a minimum of 27 mm Hg absolute.

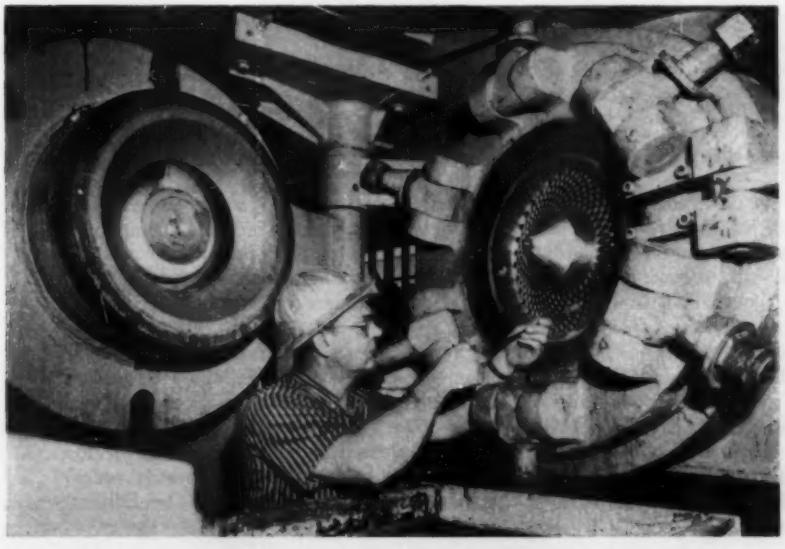

Fig. 3—Pelleting die at output end of extrusion dryer is hinged for easy cleaning. Rubber, forced by conveyor screw through holes in pelleting die, is formed into multiple strands that are cut off by rotating knives on far side of die. Pellets thus formed drop onto conveyor and are later cooled, baled, and packaged.

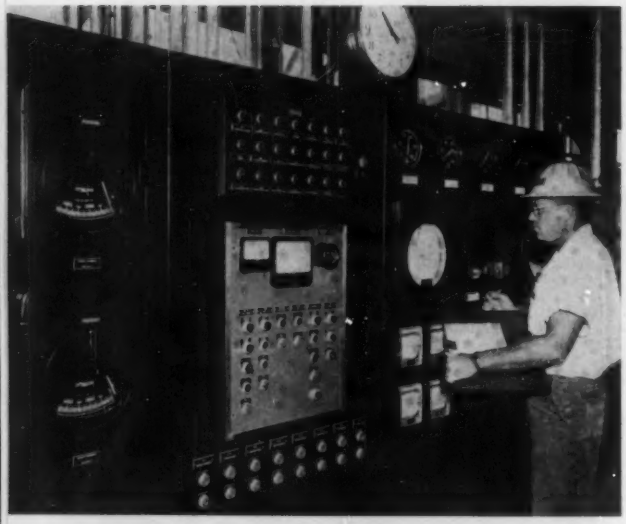

Fig. 4—Operation of extrusion dryer is directed and monitored from this central control panel. Variables controlled include motor speeds, operating temperatures, and pressures. Indicators, recorders, and gages provide data on system performance.

Following drying in the vacuum chambers, the material is forced by the conveyor screw through a circular pelleting die, *Fig.* 3. Stringy filaments of rubber, emerging from holes in the pelleting die, are cut off by a continuously rotating, double-bladed knife. The material is then cooled, baled, and readied for shipment to processing plants.

▶ Machine Control

Flexibility is designed into the machine in the form of easily adjusted material feed rates, screw speeds, valve clearances, and zone temperatures. In addition, safety provisions and monitoring devices have been included.

For temperature control, the screw section is cored to permit either heating or cooling. Under normal conditions, the maximum operating temperature of this component is 220 F. In addition, the machine has several jacketed sections so that temperatures may be adjusted at different points in the process. For example, temperature in the conical screw section is usually held between 150 and 200 F. Temperature in the vacuum chambers is 250 F, while that in the end section ranges from 80 to 100 F.

To monitor rubber temperatures, dryness, heat input to the product, and safety of operations, a system of temperature and pressure sensors has been provided. Typical points at which temperatures are measured include before and after the adjustable valve, at each vacuum chamber, and at the die plate.

A pressure measuring device in the conical screw section serves as a safety unit to prevent the machine from operating without material. If the feed, and hence pressure, drop below a preset level, power to a clutch between the drive motor and transmission will be shut off automatically. Another pressure sensor at the die plate provides a measure of the amount of working of the rubber during extrusion.

All motor, transmission, speed, feed, and temperature controls, as well as vacuum pressure and safety devices, are linked to a central control panel, *Fig.* 4. Indicators, recorders, and gages permit monitoring of many phases of the operation from the panel. In addition, a series of heavy glass ports on the machine permits visual inspection of the conveyor screw in operation.

Developed especially to prepare high grade synthetic rubbers for further processing, the unit is expected to provide an improved raw material for users who manufacture products such as insulated wire and cable, shoe soles, floor tile, tires, and automotive extrusions. Because the extrusion dryer "works" the rubber, it is expected that processors will have to spend less production time in processing their formulations. This could lead to reduced power consumption or greater capacity for their facilities.

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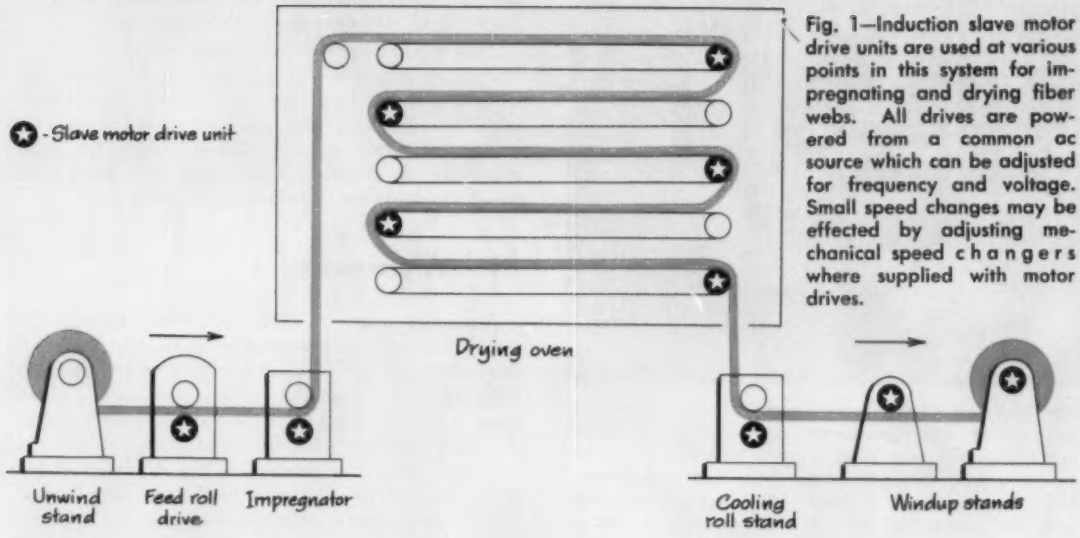


Fig. 1—Induction slave motor drive units are used at various points in this system for impregnating and drying fiber webs. All drives are powered from a common ac source which can be adjusted for frequency and voltage. Small speed changes may be effected by adjusting mechanical speed changers where supplied with motor drives.

ADJUSTABLE SPEED ESSENTIAL IN

IMPREGNATING FIBER WEBS

MANY industrial processes involve the handling of materials in web form. Typically, a web might be fed from a supply coil, passed through appropriate processing devices or equipment, and rewound into a coil. In many instances, these operations impose severe performance requirements on the drive systems that supply power to move the material.

For example, if multiple drive motors are used, it is usually necessary to synchronize their speeds so that the various drive shafts will rotate in definite speed ratios to one another. Ordinarily these speed ratios must be maintained during starting, stopping, inching, and jogging as well as normal operations. Frequently, several discrete operating speeds, or infinitely variable speeds within a range, are required. And if web tension control is important, a drive system with adjustable torque characteristics may be needed.

Drive application

Many of these drive problems were encountered by Dewey & Almy Chemical Co. Div., W. R. Grace & Co., in a processing line for manufacturing plastic impregnated fiber webs at their plant in Owensboro, Ky. The impregnated and dried material is then finished and used to form battery separators.

Major equipment items in the impregnating and drying line, *Fig.* 1, include an unwind stand, a feed roll drive, an impregnator or size press, a conveyorized oven, a cooling roll stand, and two windup stands that may be used alternately. In processing, a web is unwound from a coil; passed through the impregnator, oven, and cooling roll stand; and rewound into a coil in one of the windup stands.

Considerations involved in selecting a drive system for this line were:

1. Drying times and temperatures are such that a large drying oven was required. To drive the oven conveyors or the entire setup through line shafting was not practical.

2. A method of controlling web tension between sections of the line had to be provided.

3. Two line speeds—one for threading and one for normal operation—were required.

4. The web must not be damaged or broken during starting or stopping of the line.

5. Remote control of the system and each drive were required, including provision for emergency stopping of the line and for presetting of line speed without running the equipment.

The drive system selected for this application uses components supplied by U. S. Electrical Motors Inc. These include a power unit and a number of slave

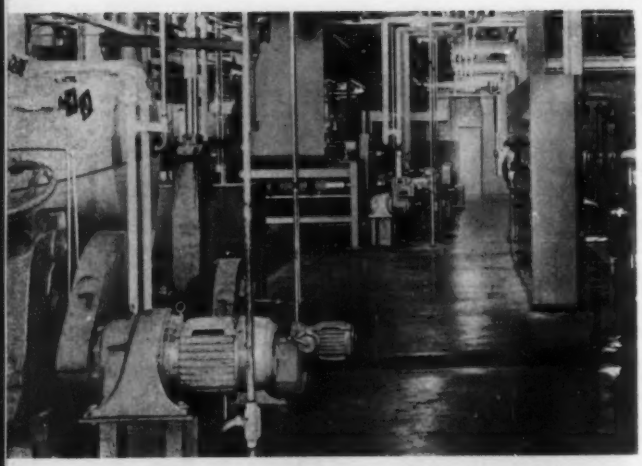


Fig. 2—View of portion of processing area shows unwind stand, left foreground, and cooling roll stand, center background. Web is taken from roll on unwind stand, passed through impregnator, and fed to overhead oven where it is dried. Web then returns vertically to cooling roll stand and is rewound on one of two windup stands.

ac induction motor drive units. Where necessary, the motor drive units are equipped with mechanical speed changers, remote electrical controls, and speed indicators.

The power unit, which drives all of the slave motors, supplies an ac output having individually controllable frequency and voltage. It consists of a two-speed, 30-horsepower drive motor and a 60-ampere alternator with associated exciter. The drive motor and alternator are linked by a mechanical speed changer. Output frequency of the alternator may be changed in two ways: By selection of one of the two speed windings of the drive motor, or by adjustment of the mechanical speed changer.

The ac induction slave motor units are placed at various points in the system, *Fig.* 1. Since they are all powered from the same source, their motors start, operate, and stop together. Small corrections in output speed may be accomplished by either manually or electrically adjusting the mechanical speed changers on the slave drive units.

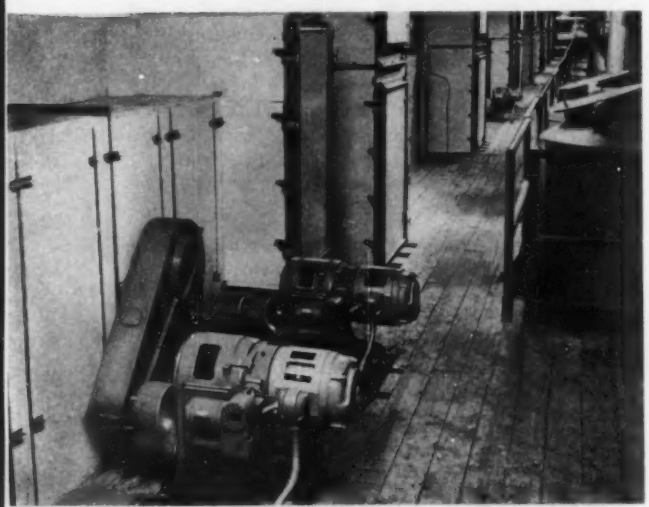


Fig. 3—Motor drive units for belt conveyors inside oven, shown, are equipped with remotely controlled speed changers. Speeds of conveyor belts can be adjusted individually to maintain proper tension on web as it moves through oven.

▸ Web processing

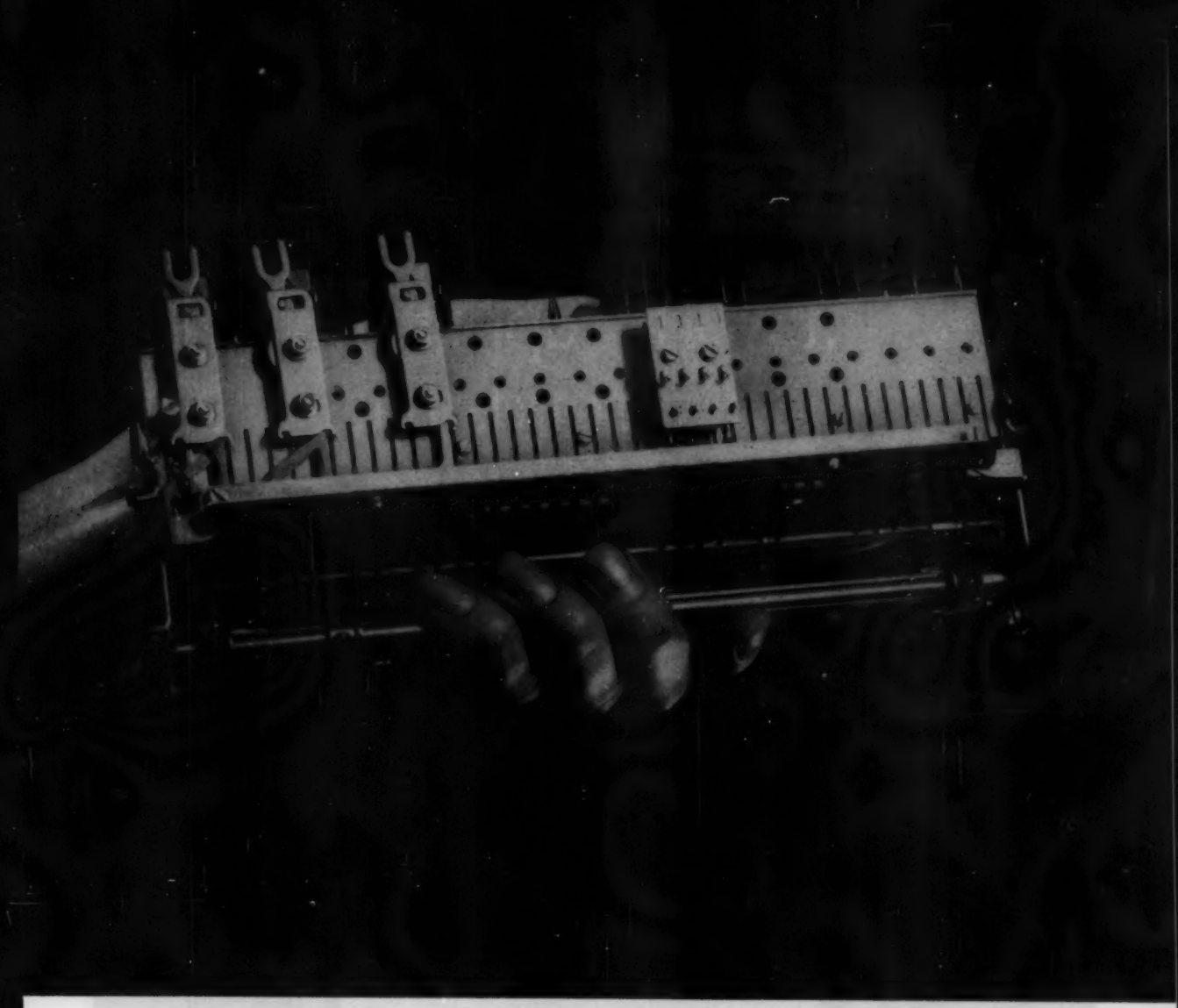
A normal processing cycle begins with threading of a web through the system, *Fig.* 2. In this procedure, the power unit drive motor is started on its low speed winding, and the leading edge of the web is pulled from a coil on the unwind stand. The web is then threaded through the feed roll drive. From the feed roll drive the web goes into the impregnator drive. Once the web is threaded in the impregnator, an operator manually adjusts the speed of the feed roll drive to maintain the proper web tension in the span between the two drive units. This tension is critical, since the web becomes relatively weak when saturated with the impregnating material.

From the impregnator the web is fed to the drying oven, *Fig.* 3, where it is moved successively over five separate conveyors. Each oven conveyor is driven by an individual slave motor drive equipped with a remotely controlled speed changer. Since the wet strength of the material entering the oven is still low, the speed of the first oven conveyor is adjusted to maintain proper web tension. The speeds of succeeding conveyors are then set so that the web does not "skid" as it is carried through the oven.

Upon leaving the oven the web is threaded through the cooling stand rolls which are driven by another slave motor drive. The speed of this drive is remotely adjusted to maintain the proper tension in the web as it leaves the oven. From the cooling rolls the web is fastened to a mandrel in one of the two windup stands. A separate motor powers each stand.

During threading the output frequency of the power unit is approximately 10 cps, which provides a basic motor speed of 200 rpm. When threading is completed, the power unit drive motor is switched to its high speed winding, and an alternator speed is selected to provide an output frequency between 20 and 100 cps. This enables operation of the system with the ac induction slave motors rotating at any desired speed between 400 and 2000 rpm. The motors will keep in step, since they all receive power of the same frequency from a common source. This characteristic makes unnecessary the use of dancer rolls or other means of compensation.

Operation of the system is controlled from a central console which contains speed selectors and indicators for the power and slave drive units, and safety devices. Thermal overload elements protect the equipment over the entire operating speed range.



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Circle 691 on Page 19

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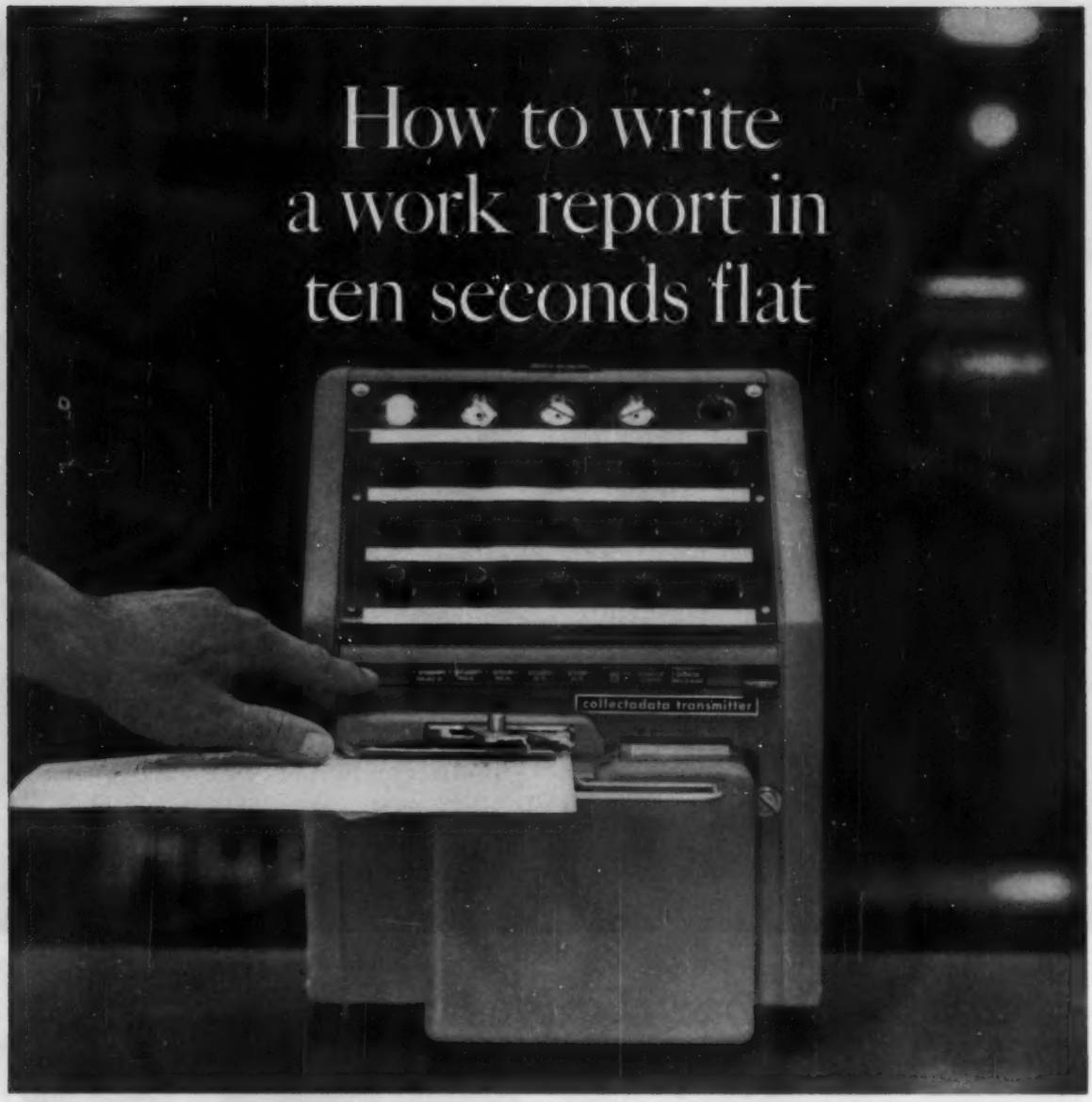

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Numerically Controlled Sliding Head Drills

DEVELOPED by **Cincinnati Lathe and Tool Co.**, Cincinnati 9, Ohio, these numerically controlled drilling machines are designed to provide for the elimination of manual positioning of work to spindle and to reduce to a minimum the need for jigs and fixtures. They are available in 24-inch medium duty models and 25-inch heavy duty models which are equipped with numerically controlled work positioning tables. Positioning of these tables is controlled by a tape control console, designated Acramatic, along two axes—10 inches forward and back and 20 inches right and left travel. This control system also provides manual positioning through selector switches. The 24-inch machine has a side arm pneumatic feed for advance and retraction of the spindle. This feed mechanism is automatically activated by numerical control. Versatility of the machines is extended by a variable speed spindle drive. Pushbutton control of this spindle speed change on the 25-inch machine, together with ease of using the tape programming system provides fast and simple changeover from one job setup to the next. The drilling machines themselves are completely standard models. The 24-inch machine has a 1-inch drilling capacity in cast iron, and spindle speeds range from 450 to 3000 rpm. It can be further customized with back gear arrangement (to decrease speed range down to 60 rpm), electrical tapping, and power feed with precision depth stop. The 25-inch model with a 1½-inch drilling capacity has spindle speeds from 60 to 1825 rpm and geared power feed. It may also be equipped with electrical tapping.

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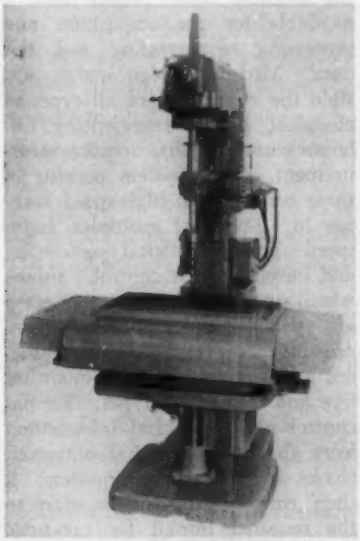
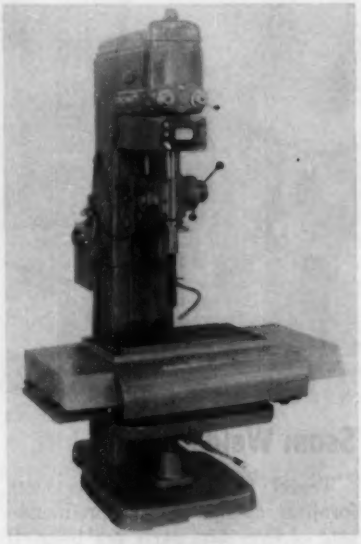


This 24-inch sliding head drilling machine has numerically controlled table positioning, as well as a side arm pneumatic feed which is automatically activated from the program tape for spindle advance and retraction.

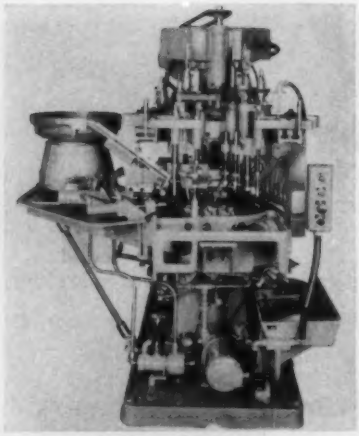


Standard 25-inch heavy duty sliding head drilling machine is equipped with a variable speed drive which increases versatility for tool room work.

Tape control console is designed to control the positioning of the drilling machines' numerically controlled worktables along two axes—10 inches forward and back and 20 inches right and left travel.

Indexing Machine

Machine is designed to produce squeeze type B-X Connectors and similar parts. The base machine, the spindle equipment, the screw feeding unit, and the air cylinder



units are off-the-shelf items. Engineering consisted of space layouts and design of fixture equipment. The operator loads a malleable casting into a nest type fixture. The top ear is drilled with a clearance drill, the bottom ear is tap drilled and then tapped. A screw is then inserted and driven through the first ear into the second ear. As inspection probe checks to see if the screw is in proper position. The part is then clamped into the nest and a slot is milled on the top ear to permit flexing of the ear when clamp-ear into the second ear. An inspec-the screw is staked to prevent it from coming out in the plating operation. The completed part is automatically ejected. Running at 25 strokes per minute, the machine performs 8750 operations and completes 1250 pieces per 50 minute hour. **Bodine Corp.**, 317 Mountain Grove St., Bridgeport 5, Conn.

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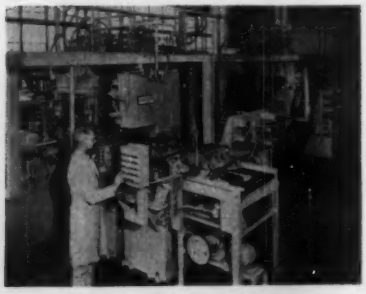

De-finning Machine

Unit is designed to de-fin automotive V-8 engine block iron castings at a rate of 240 castings per hour at 100 per cent efficiency. It applies transfer type machines to remove fins by automatic means. This machine utilizes round hardened steel punches actuated by air cylinders and hardened steel form chipping tools actuated by air hammers to remove the fins from the entire casting. Basically, this de-finning machine is a thirteen-station three-section transfer machine made up of a series of de-finning segments. Air is utilized throughout the machine. Hydraulic power is used only to index the parts and operate the locators. The parts are slid from station to station on fixed hardened rails. To keep cycle time to a minimum, the second and third sections de-fin while the first section is transferring. An automatic conveyor system is built into the machine to carry all chips and fins out of the machine. **Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich.

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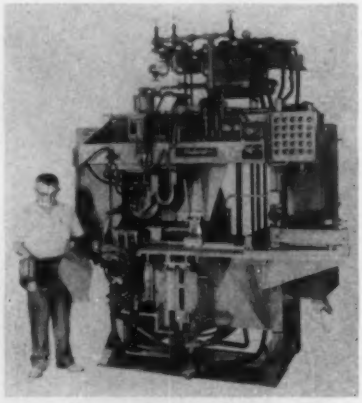
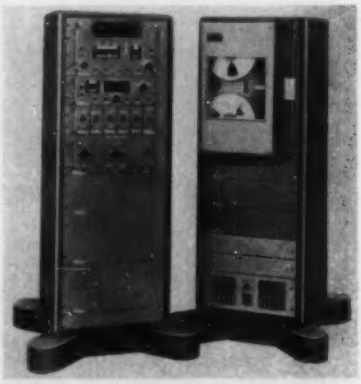


Seam Welder

Travel head seam welder with forming clamps has a production rate of over 500 parts per hour. It is used to seam weld overlap flange in a panel vent air outlet. The seam is approximately five inches long. Weld pressure is approximately 1200 lb at 60 psi. Weld speeds are adjustable from 200 to 400 in. per minute. A 200 kva welding transformer supplies the welding power. The operator loads each flat sheet blank into locators on the transfer system, and it is transferred into the forming position where it is formed into a shell. When forming is completed, it is then seam welded along the overlap edges. After the seam welding is completed, the clamps automatically release and the transfer ejects the part from the machine. **Federal Machine & Welder Co.**, Warren, Ohio.

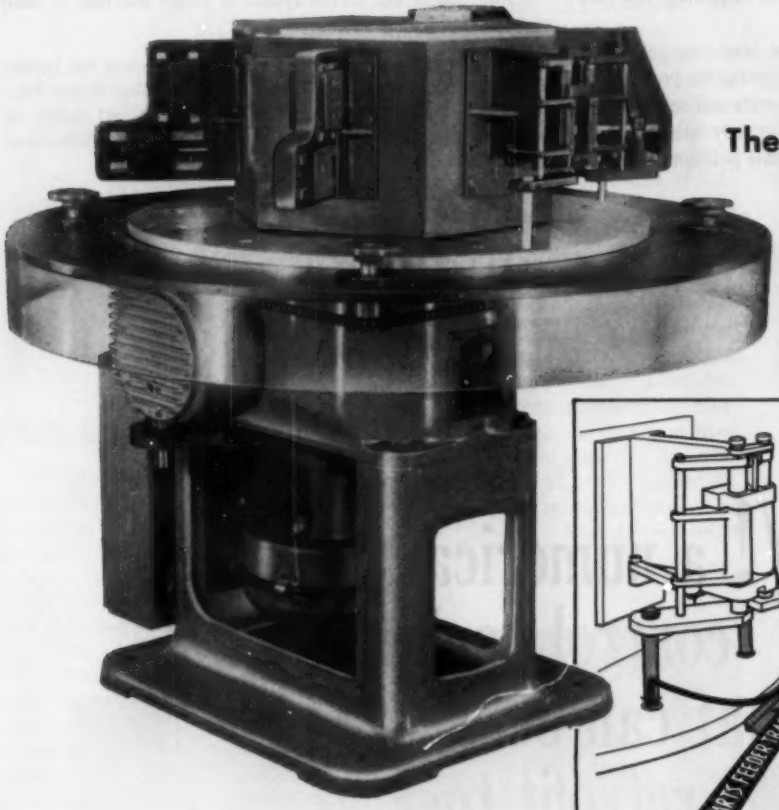
Circle 404 on Page 19



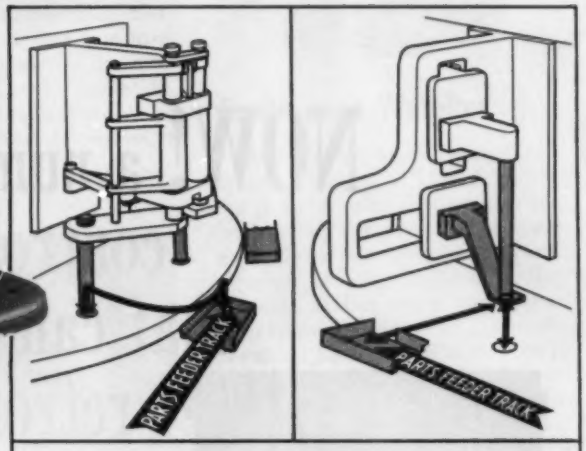
Data Acquisition System

Versatile format control is feature of high speed low level differential data acquisition system. This control provides systems programming, outputs for operating accessory print-out devices, built-in digital readout for visual presentation of data during recording and tape play back, and ability to verify and read back information recordea on the magnetic tape. Model 10000 is available for the acquisition and processing of operating and test data. Modular design makes possible the acceptance of all types of electrical signals representing different variables that require measurement. Basic system consists of three components: high-speed scanner in 10-channel multiples, high-speed analog-to-digital converter, and output format control. Inputs which may be directly connected are thermocouples, strain gages, pressure, flow and level transducers, and analyzers of both quantitative and qualitative types. Format control receives digital information from an analog-to-digital converter, clocks, or electronic counters; it then converts this information to the required format for magnetic tape programming and computer entry. Panel-mounted controls establish the different formats required. System also has built-in circuitry to drive print-out devices for parallel operation with magnetic

A NEW APPROACH to AUTOMATIC ASSEMBLY...



The machine tool concept to reduce equipment costs



Two of the standard cam actuated "pick & place" and "push & guide" stations. Each serves two dial positions. Shaded areas indicate those components attached by the user.

For the first time, medium size plants can employ automatic assembly to compete with large scale manufacturers because high volume is no longer a prerequisite to automatic production.

Ferguson's new approach to automatic assembly problems provides a standard rotary transfer machine complete with work stations that furnish parts placing motions right to the dial. The user only adds minor parts holding and positioning devices designed to conform to his production items. At the end of a production run *he changes set-up, as he would for any machine tool*, for operations on a different assembly.

Low initial cost of this standard machine means a fast pay-off on investment. Design versatility makes it adaptable for many uses and guards against obsolescence. And, as with any quality production machine tool, it is built for year-after-year performance with only normal maintenance practices.

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Hicks Development Division

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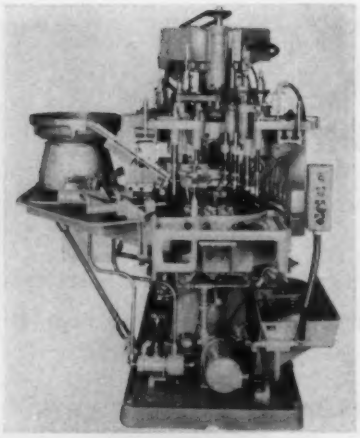
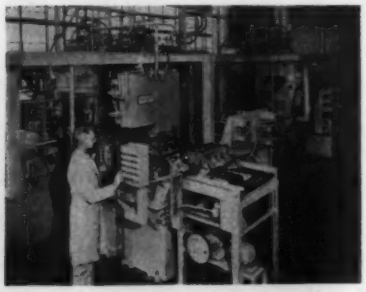


units are off-the-shelf items. Engineering consisted of space layouts and design of fixture equipment. The operator loads a malleable casting into a nest type fixture. The top ear is drilled with a clearance drill, the bottom ear is tap drilled and then tapped. A screw is then inserted and driven through the first ear into the second ear. As inspection probe checks to see if the screw is in proper position. The part is then clamped into the nest and a slot is milled on the top ear to permit flexing of the ear when clamp- ear into the second ear. An inspecthe screw is staked to prevent it from coming out in the plating operation. The completed part is automatically ejected. Running at 25 strokes per minute, the machine performs 8750 operations and completes 1250 pieces per 50 minute hour. **Bodine Corp.**, 317 Mountain Grove St., Bridgeport 5, Conn.

Circle 402 on Page 19



De-finning Machine

Unit is designed to de-fin automotive V-8 engine block iron castings at a rate of 240 castings per hour at 100 per cent efficiency. It applies transfer type machines to remove fins by automatic means. This machine utilizes round hardened steel punches actuated by air cylinders and hardened steel form chipping tools actuated by air hammers to remove the fins from the entire casting. Basically, this de-finning machine is a thirteen-station three-section transfer machine made up of a series of de-finning segments. Air is utilized throughout the machine. Hydraulic power is used only to index the parts and operate the locators. The parts are slid from station to station on fixed hardened rails. To keep cycle time to a minimum, the second and third sections de-fin while the first section is transferring. An automatic conveyor system is built into the machine to carry all chips and fins out of the machine. **Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich.

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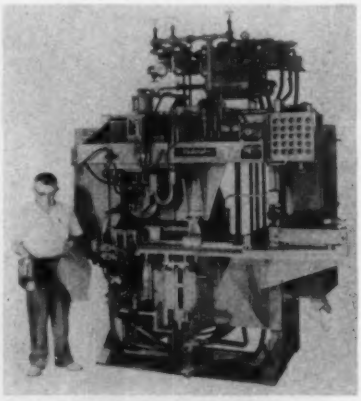

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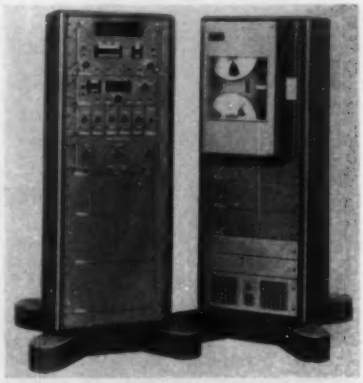
Circle 404 on Page 19



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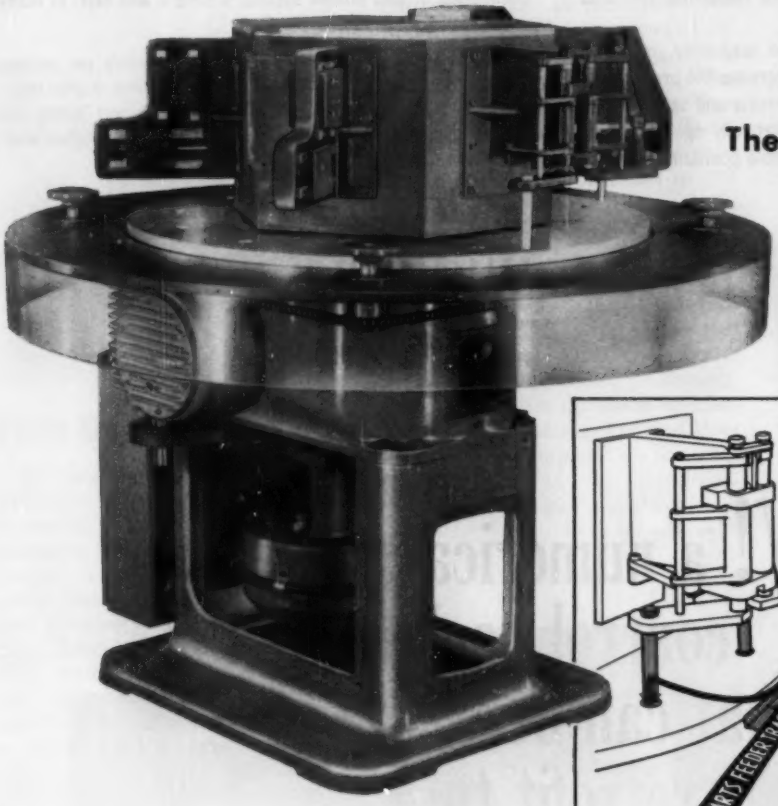

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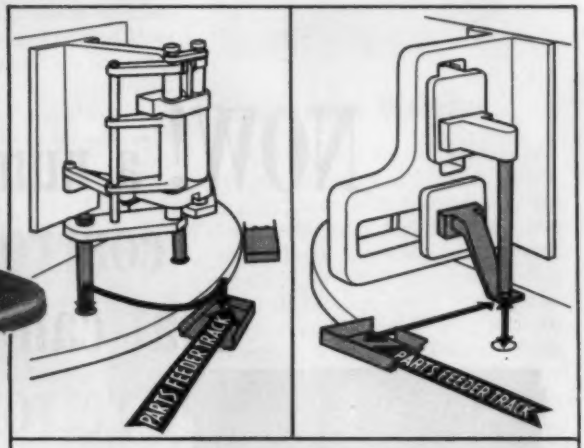

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Circle 693 on Page 19

See the Hughes two-axis positioning system in operation at the ASTME Show in Los Angeles, Booth 445

Hughes two-axis control system, with positioning table, can be retrofit to almost any kind of drilling machine—single or multiple spindle—or to any other type machine requiring two-axis positioning.

Hughes numerical controls will reduce lead time, eliminate complex jigs and expensive tooling, and increase the productivity of your machine. And, they are easy to operate and service!

The Hughes Positioning Table is automatically operated from pre-programmed taped instructions. The table positions at a rate of 150 inches per minute; has repeatable accuracy to within 0.0002". Measuring circuit and drive motors are fully integrated.

Installation of this proven system is simple and fast. In many cases, all it takes is one day.

To find out more about how Hughes numerical controls can increase your profits, write, teletype (TWX INGL 4117) or call collect: Hughes Industrial Systems Division, P.O. Box 90904, International Airport Station, Los Angeles 45, California. For export information, please write: Hughes International, Culver City, California.

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INDUSTRIAL SYSTEMS DIVISION
HUGHES AIRCRAFT COMPANY

NOW! a numerical control package that can be retrofit to your present machine tool

Circle 694 on Page 19

tape unit. Scanning speed of the unit is 600 channels per second. **Electro Instruments Inc.**, 3540 Aero Court, San Diego 11, Calif.

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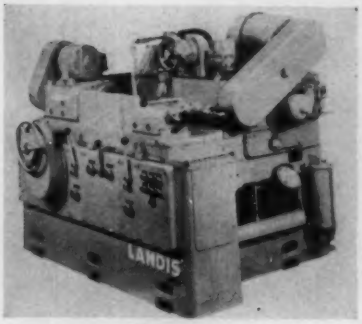

Plain Grinder

Six-inch plain grinder features a hydraulic system which has no open hydraulic drains in the bed. The hydraulic reservoir and motor are located independently of the machine. Model R has an intermittent slow grinding feed for traverse grinding. There is a total feed of 0.082 inch on diameter at each or either end of traverse. Lever controlled rapid wheelhead movement permits a continuous, slow grinding feed in addition to intermittent feed. On jobs where the amount of stock to be removed is not too uniform, a lever controlled grinding feed speedup is available for faster operation on machines equipped with hydraulic rapid wheelhead movement. The rapid approach is set to stop clear of the largest piece of unground work. **Landis Tool Co.**, Waynesboro, Pa.

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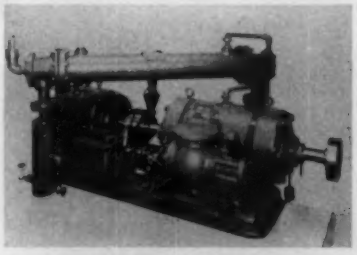

Rotary Compressor

Line of compact, preassembled two-stage rotary compressors, of the multivane type, is designed specifically to simplify installation and foundation problems. Featuring an overhead intercooler for greatest possible compactness, the unit can be placed for operation in the field either on a floor or mezzanine. All that is necessary at the scene of installation is the addition of a motor and air and water piping. The line includes two-stage models from C60-60H to C300-300H. These cover capacities from 279 to 3300 cfm and discharge pressures to 125 psi. Direct connection can be made to electric motors, gas motors, or gear-turbine drives. Each stage comprises a cylinder with heads, thoroughly water-jacketed. Intake and discharge openings are located in a horizontal plane on opposite sides of the cylinder. Compartments vary from minimum to maximum on the suction side, and from maximum to minimum on the compression half of the revolution. **Fuller Co.**, Catasauqua, Pa.

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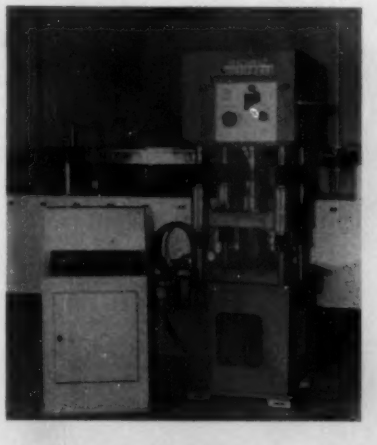

Hydraulic Press

High-speed 25-ton hydraulic press is capable of delivering over 600 ram strokes per minute. It contains a closed circuit hydraulic system and servo drive, with harmonic cam drives for work strokes of ¼, ½, ¾, 1, 1½, 2, and 3 inches. Cams can be varied to permit special work strokes. The number of ram strokes can be changed while the machine is cycling. Range of punch breakthrough adjustment is 1 inch, in increments of 0.001 inch. Speeds and pressure adjustments are controlled electrically. Controls are mounted on an electric console panel. Both the press frame and power unit are shock mounted. **Denison Engineering Div., American Brake Shoe Co.**, Columbus, Ohio.

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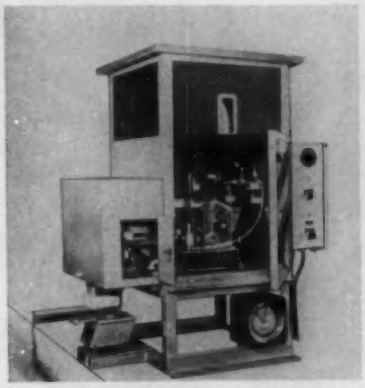

Continuous Weigher

Machine for high-precision continuous weighing of loose, free flowing granular solids features a system for inserting dry additives into processing lines operating by conveyor, pipeline, or other continuous flow methods. It has many applications in processing streams of chemicals, plastics, foods, fertilizers, feeds, seeds, drugs, powdered metals, and similar products where highly concentrated additives must be inserted in exacting quantities. Placed over a product stream, a precision scale with over-and-under indicator weighs precise amounts of the additive in a net weigh hopper. An air operated mechanism then dumps the additive into a small, secondary hopper which feeds the additive into a vibratory feeder. From the vibratory feeder the additive is introduced into the continuous processing line in a uniform flow. Quantities handled can range from one oz to three lb and three to 10 lb. Supply hoppers and feeder conveyors are available in various capacities. Multiple units of two or more machines may be combined to increase the number of weighings per minute. Machines can be arranged as single production units or they may be electrically synchronized with discharge chutes designed to deliver the product through a single spout. **Exact Weight Scale Co.**, 538 E. Town St., Columbus 15, Ohio.

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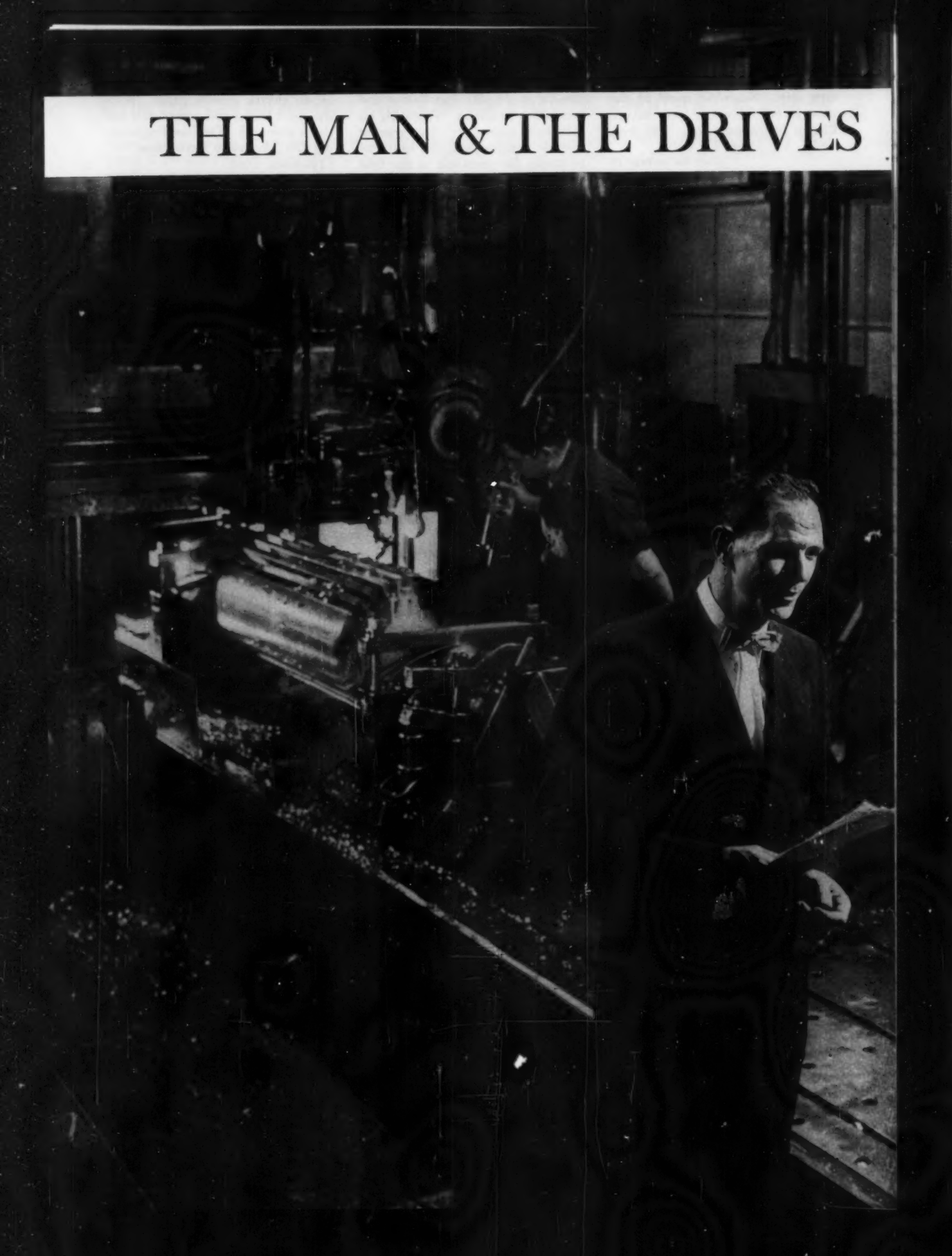
THE MAN & THE DRIVES



FROM WESTINGHOUSE

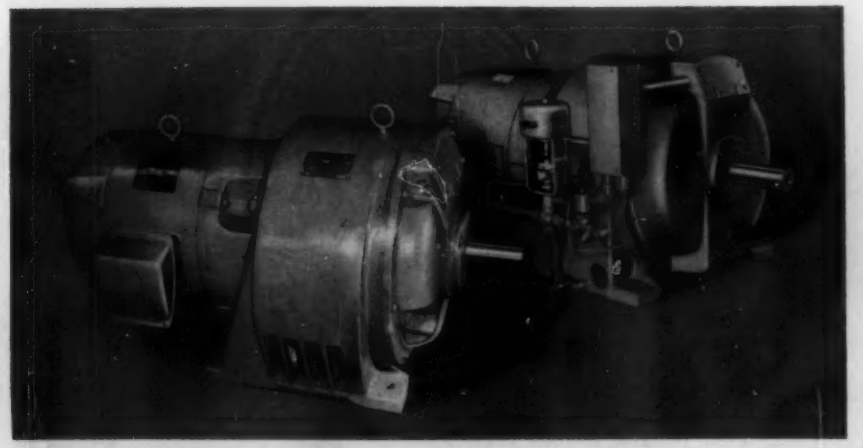
Mr. Westinghouse and MagnaFlow Drives Bring Simple Solution to Speed Control Problems, Save Money and Space, Too!

Westinghouse MagnaFlow* electromagnetic drives—air or liquid cooled—provide infinitely adjustable speeds from standstill to top speed with regulation guaranteed at $\pm 2\%$ of top speed over a 17-to-1 speed range (even closer regulation when desired). Control is smooth and stepless.

These compact drives, having a minimum number of parts, are built for rough, trouble-free service. The unique electromagnetic coupling maintains adjustable output speed without the use of pulleys, belts, brushes, commutators, slip rings or rotating windings. A rugged Life-Lin3® "A" motor supplies reliable a-c drive power. No power converting equipment needed—only a small, static exciter and an operator's control station. Initial cost is low; installation—easy and inexpensive.

Your Man from Westinghouse is ready now to help you apply MagnaFlow drives . . . and any other drives you may need. Call him . . . or write for a copy of Westinghouse MagnaFlow Electromagnetic Drives (B-7875), Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse. J-22162

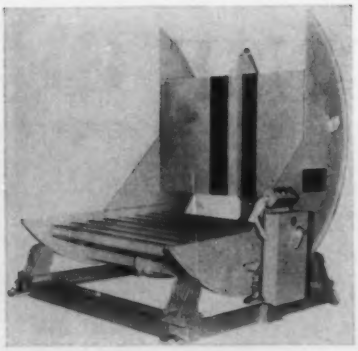
*Trade-Mark



MagnaFlow drives—air cooled (foreground) and liquid cooled—are available in various horsepower ratings for winders, conveyors, fans, pumps, extruders and other machinery in all industries.

Westinghouse

Circle 695 on Page 19



Coil Upender

Equipment handles coils of metal strip that are delivered flat to fabricating plants without hoists, slings, or cradles. The coil is slid off the truck onto the upender which then turns the axis through 90 degrees and places the coil in a vertical position. This position permits transportation of the coil by a bar or mandrel equipped lift truck. The coil is handled in such a manner so as to protect the finish of the coiled strip. **Roth Corp.**, Box 29, New London, Ohio.

Circle 410 on Page 19

Oscillograph

Low and medium gain direct writing oscillograph designated Model RD Dynograph is available for systems applications and telemetering. It can be obtained in a variety of mountings, including standard racks. Completely transistorized, the Dynograph provides instant operation with no stabilizing warm-up. Using a common power supply, each amplifier is replaceable. Sensitivity is 10 mv per cm to 100 v per cm, and drift is 0.2 mv per hour at maximum sensitivity. Frequency response is to beyond 200 cps, +10 per cent; zero suppression is ±40 cm. Ink or electric curvilinear; heat or electric rectilinear recording media may be used. One to eight standard channels are available with Type 504A rack-mounted paper drive. On other mountings, there can be up to 24 channels. **Offner Electronics Inc.**, 3900 River Rd., Schiller Park, Ill.

Circle 411 on Page 19

Heating Machine

Utilizing a building block concept consisting of a portable monitor control panel mounted on a portable heating station, this machine has a scanning mechanism which is used to spin-progress the part vertically through the heating coil of the station. Power for the unit is furnished by a motor driven, vertical generator. Infinitely variable feed rates are provided with the use of dc electronic motor drives. Muplticircuit timers for accurate control of spot heating applications and replaceable stainless steel centers permitting fast change for greater work variety are included. The portable monitor control panel consists of two units, the control section and the power section. This design permits back-to-back mounting or side-by-side for wall mounting. The portable heating station is offered in 7½ to 30 kw with high-frequency line contactor station or 50 kw without high frequency line contactor. **Meta-Dynamics Div., Cincinnati Milling Machine Co.**, Cincinnati 9, Ohio.

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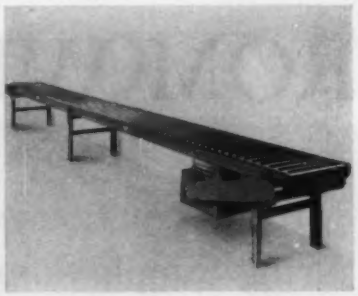

Live Roll Conveyor

Unit is designed so that the weight of the articles being conveyed causes the automatically adjusted carrying rolls to regulate belt tension to the amount proper for the load. This feature eliminates manual adjustments and conserves power. Capacity of Series E Unibuilt live roll conveyor is designed so that the conveyor is both adequate and economical to meet all normal requirements — especially those where holdback or deflection in loading or unloading is desired. Unit is available in a wide variety of widths, with roll spacings and lengths to suit requirements. End drive and center drive models are standard design. **Conveyor Specialty Co. Inc.**, North Quincy, Mass.

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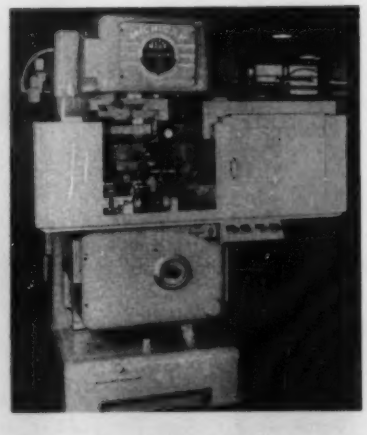


Gear Shaving Machine

Line of rotary gear shaving machines, designated 870 Mark II, consists of three types of machines —an underpass, an internal, and a universal gear shaver. The universal model permits selection at will of underpass, modified under-

NEW

MODEL III

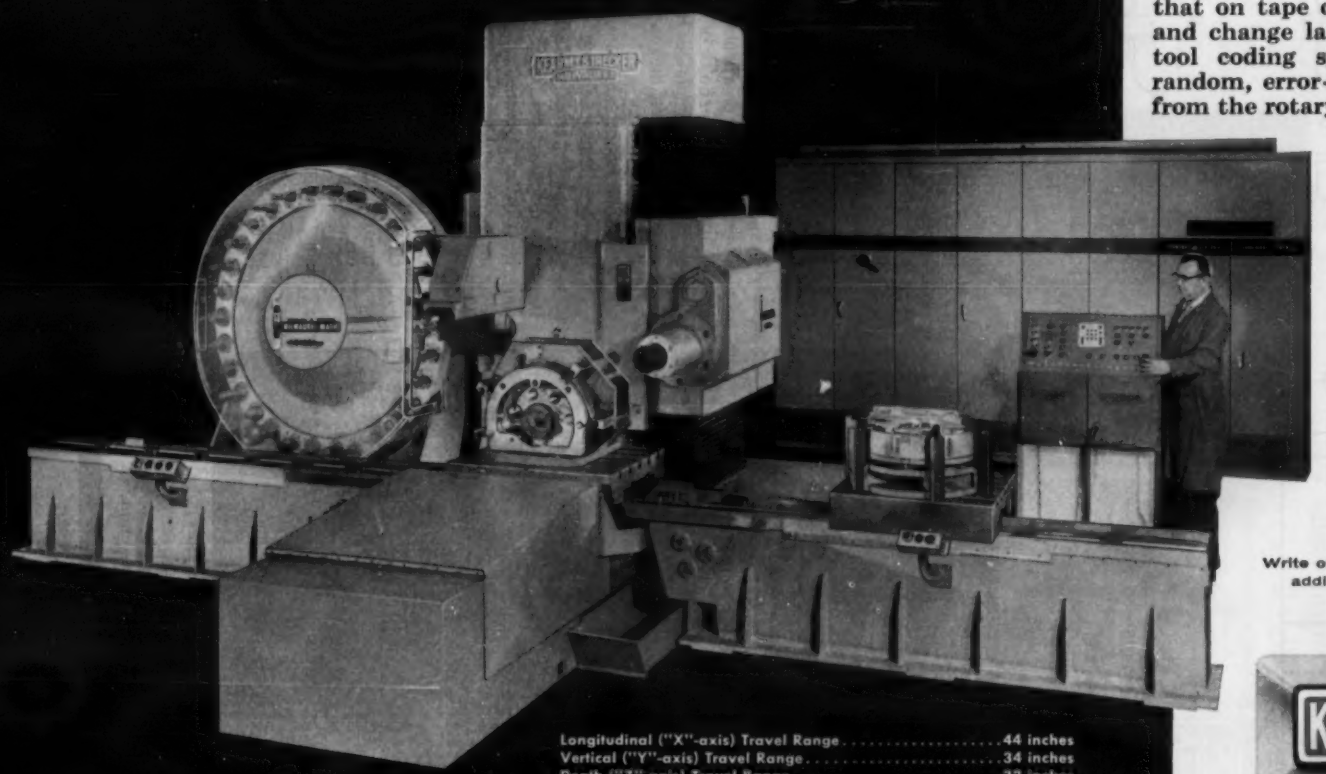
KEARNEY & TRECKER

MILWAUKEE-MATIC

WITH THE

AUTOMATIC TOOL CHANGER

that on tape command can automatically select and change large tools in 15 seconds. Exclusive tool coding system provides for the possible, random, error-free selection of 961 different tools from the rotary tool storage magazine.



This new, time-slashing, profit-producing MODEL III extends the *Manufacturing with* MILWAUKEE-MATIC *CONCEPT* to larger workpieces . . . combines high horsepower with high precision.

"*. . . almost human — only better — it doesn't make mistakes*" . . . "*I see it, but I still don't believe it*" — were typical of the comments made by experienced machine tool buyers, on seeing this pace-setting MODEL III in action here at the birthplace of the *Manufacturing with* MILWAUKEE-MATIC *CONCEPT*.

Longitudinal ("X"-axis) Travel Range	44 inches
Vertical ("Y"-axis) Travel Range	34 inches
Depth ("Z"-axis) Travel Range	32 inches
Work Pallets—Surface Area	28" x 36"
Automatic Index Table—to any of 360-1° positions	at 5 rpm
Rotary Tool Storage Magazine	30 tools capacity, plus one tool in spindle
Max. Tool Dia. Automatically Changed	6 inches

Tools can be added to, or removed from any position in the magazine at any time.

Write or call for complete information on this new addition to the MILWAUKEE-MATIC family.

Numerical Control Division

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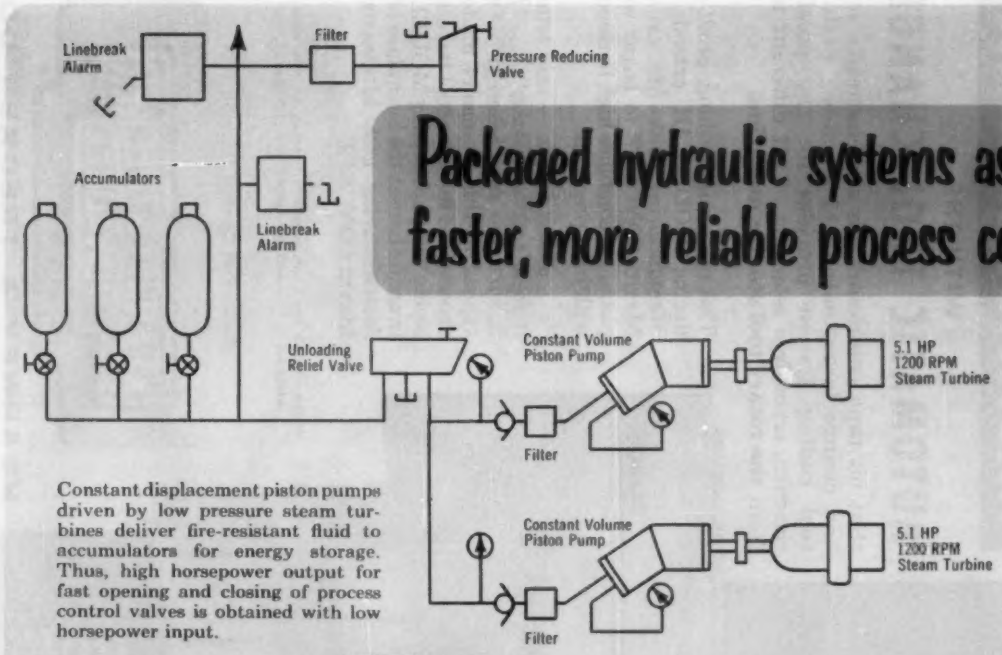
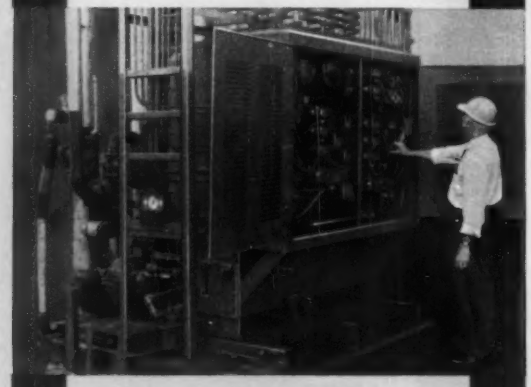
Circle 696 on Page 19

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

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ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan

9138

pass, or transverse shaving. The machine is available in three sizes for gears up to 8, 12, and 18-inch diameter respectively (up to 12-inch for internal gears). The majority of machine settings are dial controlled. Feed rates of ½ to 10 inches per minute are possible. All controls and adjustments are accessible from the outside of the machine. Gear face widths up to five inches can be shaved with this machine. Range of the air-operated positive upfeed is from 0 to 0.040 inch in increments of 0.001 inch. Choice of four fine upfeeds, ranging from 0.0005 to 0.002 inch per stroke, are possible by setting a control pointer and two counters back of the front door in the machine base. Dual *Start* and *Jog* buttons are provided on each machine. The machines are available with a compact attachment which permits either or both crowning or tapering of teeth at the same time during transverse or modified underpass shaving. All gears and bearings operate in sealed pump type reservoirs, with visual sight gages provided. Optional equipment includes an electrical sensing device for interrupting shaving action if work has excessive stock to remove. **Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit 12, Mich.

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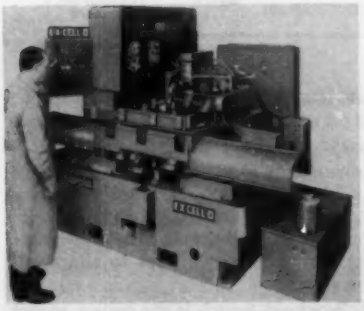

Tape Controlled Machine

Numerically controlled machine can be converted from a templet grinder to a boring and turning machine through interchangeable heads. The machine is designed to operate from any high performance numerical control system. Features of the unit designated Model 922 Numera-Trol include: Rigid bed, hand scraped antifriction ways, lead screws with recirculating ball-type antifriction screw and nut assemblies, and preloaded ball thrust bearing supports on each end. Only 5½ lb of direct pressure is required to overcome initial inertia of the cross slide. Quantizers geared to the servomotors provide closed loop feedback sensitive to incremental pulse values of 25 millionths of an inch. **Ex-Cell-O Corp.**, 1200 Oakman Blvd., Detroit 32, Mich.

Circle 415 on Page 19

Turret Indexing Unit

Developed for high-speed, automatic assembly and processing operations, this turret indexing machine chassis employs double overhead tool plates for the mounting and actuation of tools. A major portion of the tooling on this unit is mounted and actuated by a pair of tool plates which are centermounted above the indexing turret. These plates are designed to move up and down with definite relative motion and are cam actuated in synchronization with the main indexing camsaft. Tools are centermounted, facing outward, and provisions are made to permit feeding and escapement of parts as well as probing and orienting. Additional tooling such as hoppers and processing equipment may be mounted on external mounting brackets around the outside of the turret. This external tooling can be mechanically actuated by cams and levers operated from the main indexing camshaft or by some auxiliary source. **Swanson-Erie Corp.**, 816 E. Eighth St., Erie, Pa.

Circle 416 on Page 19

Shaft Inspection Machine

Unit is designed specifically for dimensional checking of axle shaft forgings. Employing the standard "off-the-shelf" type gaging modules, the machine checks the shaft for run-out (three places) and out-of-roundness (two places) as well as OD and length. The flange is inspected for thickness (360 degrees) and run-out in reference to the shaft. Operating at speeds of up to 600 parts an hour, the axles are automatically classified as acceptable or reject. Sizes handled range from 28 to 33 inches in length, and 6 to 8 inches in flange diameter. A control panel gives a continuous visual presentation of the operation at all times. The same unit can be used for inspection of finished axles. **Industrial and Automation Div. Radio Corporation of America**, 12605 Arnold Ave., Detroit 39, Mich.

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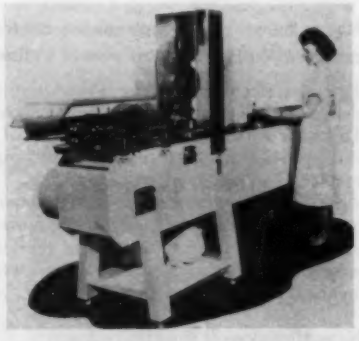
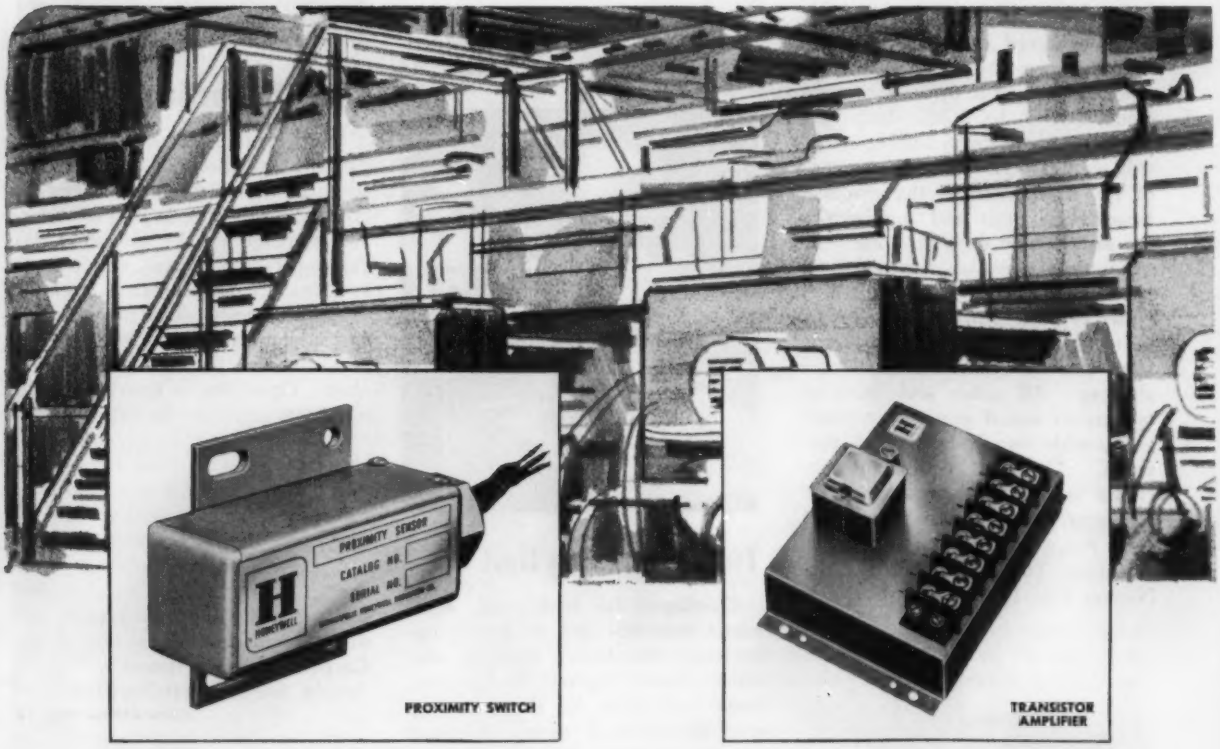


Lid Closure Machine

Designed for large volume high-speed folding and crimping of aluminum foil rigid containers, continuous feed, lid closure machine operates at speeds of 30 to 110 closures a minute. Model 3-B can

NO MOVING PARTS TO WEAR OUT!

New Honeywell Static cuts down time,



Never before such dependable control of pneumatically-operated power cylinders!

This new electro-pneumatic power team includes a proximity switch with a transistorized amplifier to transmit its signal. This output is fed directly to the coil of a unique pneumatic valve, providing high-speed static switching up to 600 cycles per minute. The system is so adaptable and foolproof, it can be used to meet almost any production line requirement, and can be expected to last the life of the equipment. With no moving parts, it needs no maintenance or lubrication, and offers the utmost in reliability. Especially designed for industrial environments, it is impervious to dust, water, oil and abrasives.

New Honeywell Proximity Switch tackles tough automation problems

This industry proven switch will stimulate new ideas for updating machines and methods. It detects metal parts that pass within ½" of the sensor without ever touching them. It will operate up to 600 times a minute at temperatures up to 200 degrees F. And it needs no warm-up time—it's ready to operate the moment it is energized.

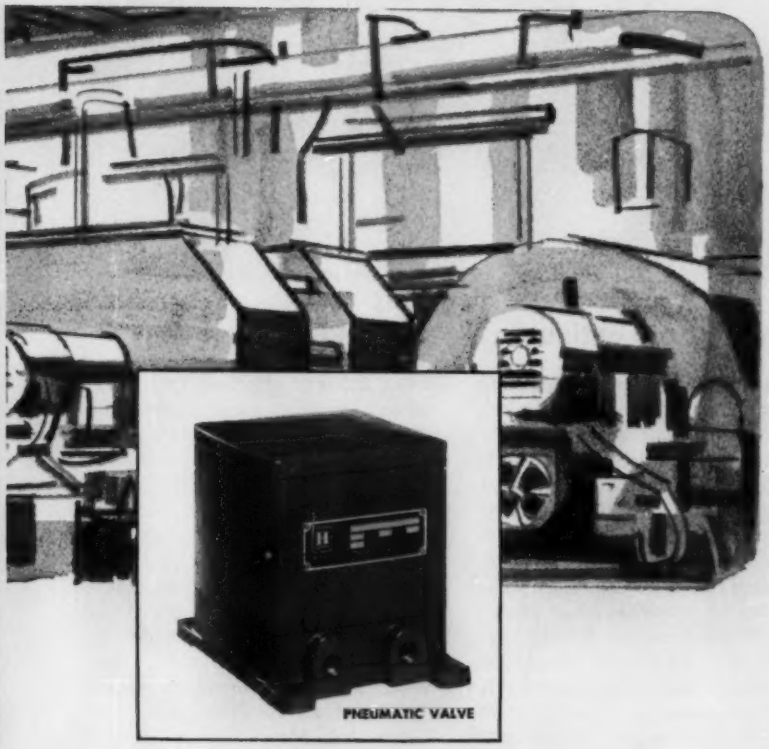
Because it has no moving parts to wear out, it need never be replaced. The rugged stainless steel face is sealed against cutting oils, filings, humidity, sand and dust. The sensor can even operate when it is submerged. And it's simple to install because there are no mechanical actuators or linkages to adjust. It operates on normal line voltages.

This new Honeywell Proximity Switch is the perfect answer where rough parts or corrosive atmosphere may damage a mechanical switch, or where the delicate finish of a product might be marred by physical contact.

The transistorized amplifier, containing a field-proven Honeywell circuit, gives sensitivities from 1/16" to ½" at the sensor. The transistors mean no warm-up time is required and the sensor will operate instantly. Amplifier can be mounted up to 150 feet from the sensor and wiring need not be shielded. JIC enclosure available.

See us in Sweet's 1960 Product Design File, Section 5b-Min

Power Team speeds production



Most reliable pneumatic valve of its kind is designed to last up to 40,000,000 cycles

At last, here's a valve built to give service rather than to be serviced. And you'll find it the most adaptable pneumatic valve ever designed for transfer line, punch press and welding machine operations.

A change of manifolds permits either ¼", ⅜" or ½" valve sizes—makes it a 3-way or 4-way valve. Reverse the power head and you change it from a reverse to a direct-acting valve. Even the porting arrangements can be changed.

What's more, you get fast response (up to 600 cycles per minute), high capacity, with little or no maintenance required. The coil life is guaranteed for the life of the valve. For long, trouble-free service and money-saving features, no other valve compares with Honeywell's new V4032A, B and V4033A. Built to JIC specifications.

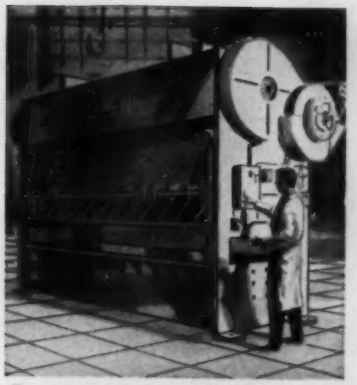
For additional information on the static power team or on any one of the components, call your local Honeywell office. Or write Honeywell, Minneapolis 8, Minnesota.

75th YEAR — ENGINEERING THE FUTURE

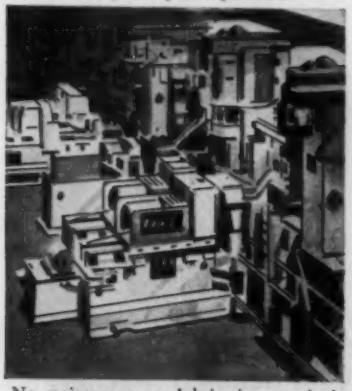
Honeywell

First in Control

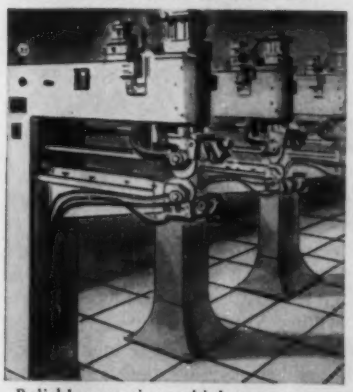
SINCE 1885



Fast response and long life solve two big problems in power press operation.



No maintenance or lubrication required reduces down time on transfer lines.



Reliable operation at high temperatures make this team ideal for spot welders.

Circle 698 on Page 19

be used for the closure of any size and style container—regular edge vertical flange, interrupted vertical curl, curled edge with round and rectangular foil hood lid, and beaded with hood lid. Conversion from the closure of one style container to another may be made in a matter of minutes by simple closure head and container holder changes. A positive gear action maintains the proper timing cycle for uninterrupted operation of the machine. The machine is designed to meet the most rigid food processing requirements and may be washed with water without any harm to its operation. Maintenance is virtually limited to periodic lubrication. **Container Div., Anaconda Aluminum Co.**, P. O. Box 1654, Louisville 1, Ky.

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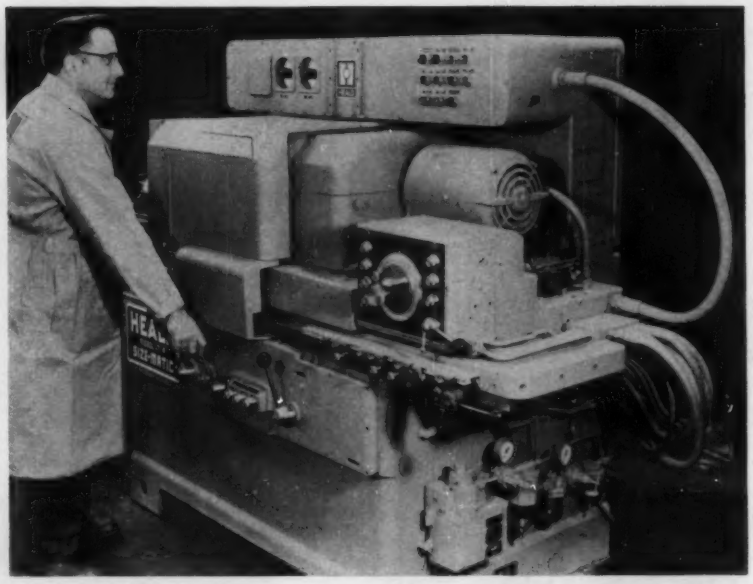

Impulse and Continuous Feed Grinders

Impulse feeding makes possible straighter bores with smoother finishes for long bore ratios on Model 171A internal grinder. The wheelhead on this machine is mounted directly on the cross-slide and feed is accomplished by moving the wheelhead into the work. This arrangement permits heavier roughing cuts with a minimum of distortion. Workpieces to 8-inch OD (10-inch OD in special cases) can be accommodated. The machine is capable of taking work with a 90 degree included angle. Either constant or impulse feeding can be selected through the feed box. Infinitely variable compensation for wheel wear (from 0 to 0.004 inch) aids in maintaining tolerances and promotes longer wheel life. Accuracy is improved by locating heat-producing hydraulic equipment outside of the machine base to prevent thermal distortion. Miniature dc solenoid valves speed up cycles. This internal grinder is available in three models, sizematic, gage-matic, or plain. **Heald Machine Co.**, 15 New Bond St., Worcester 6, Mass.

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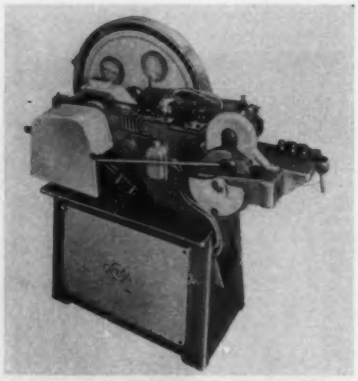

Cold Heading Machine

Open die precision cold heading machine for making long, thin parts such as lead wires, pins, or rivets comes equipped with motor and V-belt drive. Production rates, of 60, 90, or 110 pieces per minute on parts up to 2⅜ inches in length with a nominal wire capacity of 0.020 to 0.090-inch diameter are possible with this machine. It is furnished with two sets of straightening rolls, a 9 roll straightener for fine wire up to 0.036 inch and an auxiliary 5 roll straightener for wire sizes of 0.036 to 0.090 inch. One-shot lubrication system and a set of prototype tools are part of standard equipment. **REM Sales Inc., Subsidiary, Robert E. Morris Co.**, Box 41, West Hartford, Conn.

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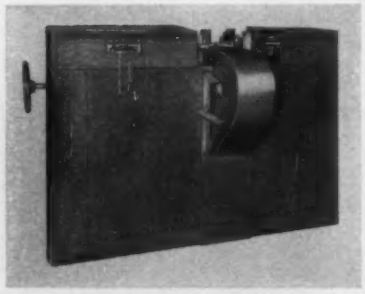
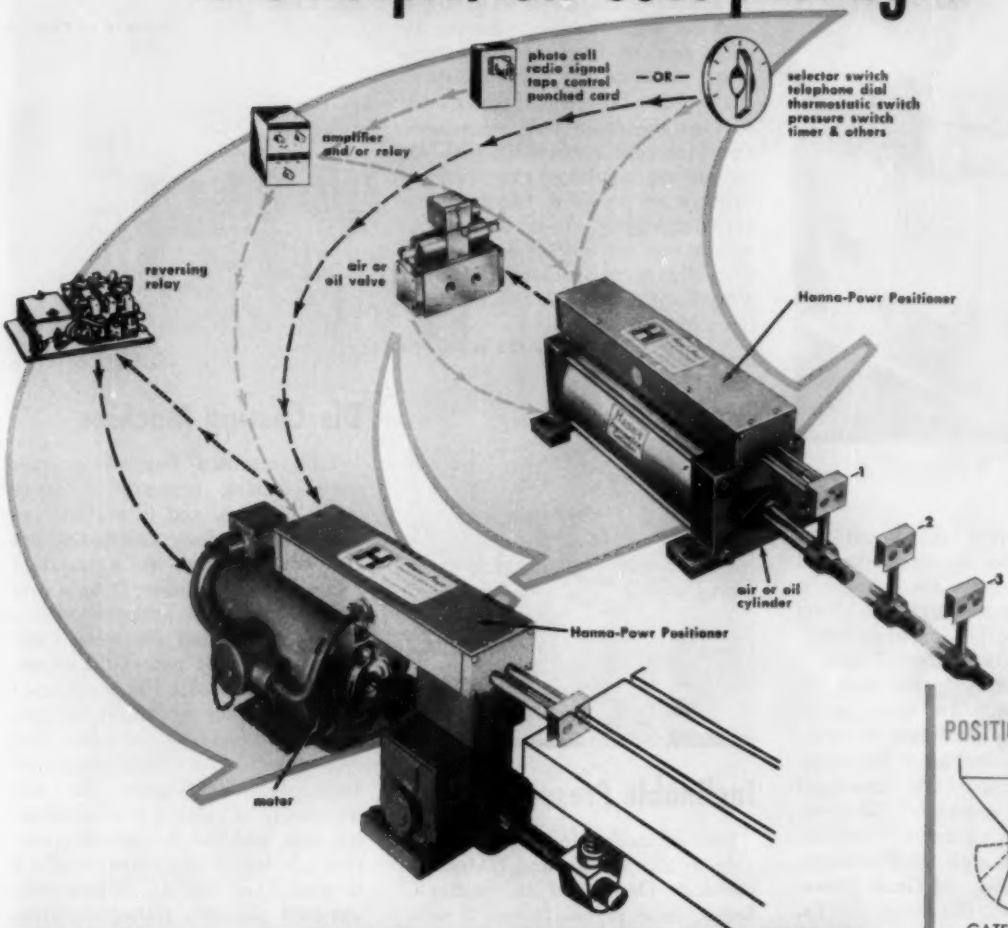


Silk Screen Printer

Device is capable of reproducing trademarks, logotypes, nameplates, directions, operational instructions, labels, dials, and clock faces directly on products and/or components. Special applications in electronics include printed circuits, wiring diagrams, conductive coatings on ceramic discs and mica capacitors, rectifiers, and thermistors, as well as resistance coatings on ceramics and phenolics. This silk screen printer permits laboratory and research pilot production prior to major investment in mass production machinery for product and/or part identification. It can be easily integrated with existing assembly lines. The printer can print small parts at a relatively fast rate. It prints an area up to three square inches with accuracy within 0.004 inch, and will print any flat sur-

BRAND NEW IDEA... multiple positioning in a simple, low cost package!



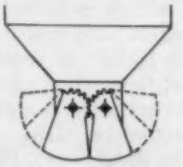
HANNA-POWR® POSITIONERS

THE NEW HANNA-POWR POSITIONER is a simplified, low-cost servo-mechanism used with air or hydraulic cylinders, electro-mechanical or other power drives to responsively achieve predetermined positions. The POSITIONER will also feed a signal to a read-out station to indicate the position point. Controls, such as selector switches, timers, thermostatic switches and others, feed signals to the POSITIONER for station selection—as many as 14 per foot of stroke. Infinite variations in positions are possible by simple movement of the adjustable limit switches. Stroke lengths may vary from a few inches to several feet to suit each application.

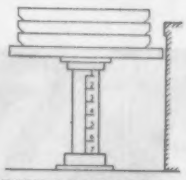
HANNA-POWR POSITIONERS save the time of designing special controls and cams, offer convenience of installation with one simple mounting for a group of controls, and cut maintenance costs by protecting all controls in a sturdy, dust-tight housing.

Your individual problems will suggest many uses for the HANNA-POWR POSITIONER. For more detailed information call your nearby Hanna Representative, (See "Cylinders" in the yellow pages), or write us for Catalog 500.

POSITIONED POWER



GATE POSITIONING



MULTIPLE POSITIONING OF LOADS

INDEXING

60 Years' Experience In Building The Finest Cylinders, Valves and Other Hydraulic and Pneumatic Equipment

Hanna Engineering Works

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face that will take paint, regardless of material or color. Objects of different size may be printed merely by switching silk screen frames, jigs, and tools. **Automation Equipment Inc.**, 51 Prince St., Wallingford, Conn.

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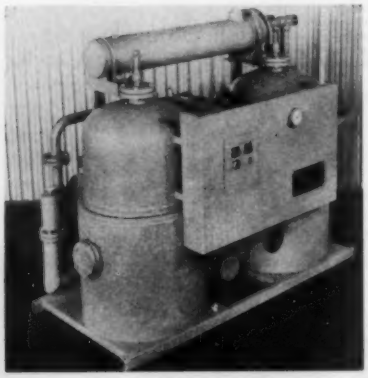

Gas Dryer

Line of drying equipment has been designed for drying compressed air and other gases for instrument line service. Dryer designated Model BZ is dual adsorber, pressure-reactivated unit. Parts of the BZ Ledtrodryer are interchangeable, and the few moving parts are easily accessible. Working on a six-hour cycle, it adsorbs moisture, heats for regeneration, and cools. Only occasional lubrication is required. Adequate instrumentation permits checking the operation at a glance. **Pittsburgh Lectrodryer Div., McGraw-Edison Co.**, 32nd Street, Pittsburgh 30, Pa.

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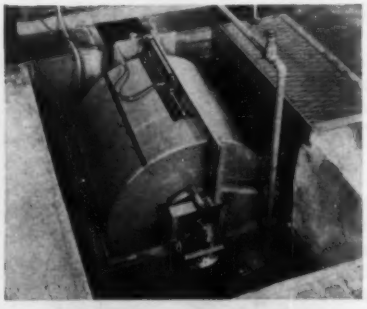

Rotary Industrial Filter

Compact strainer type rotary industrial filter is designed to provide unusually large filtering capacity in proportion to floor space occupied. Model 10 uses eight simplified, screw-mounted screens on a rotating drum. Reciprocating air nozzles peel the caked contaminant from the screens and no filter media is thrown away. Air pressure requirement of the unit is 40 to 60 psi, and air usage is approximately 16 cubic feet of free air per minute when the filter is in continuous use. An optional float switch is available to turn the drum only when contaminant cake restricts filtering. An air presure regulator, gage, and lubricator are provided. Filter may be used separately or in tandem, to service one machine or as a central filter for many machines. **Murray-Way Corp.**, P. O. Box 180, Birmingham, Mich.

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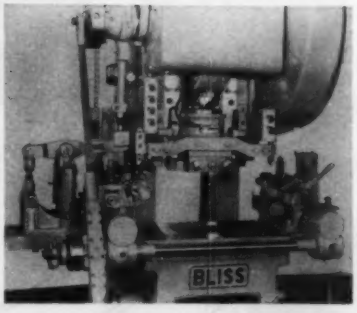

Inclinable Presses

Line of inclinable presses is available in 22, 35, 45, and 60-ton capacities. Designated as the Big C Series, these presses feature a redesigned cast Meehanite frame which reduces deflection up to 50 per cent. This reduced deflection contributes to a higher degree of parallelism between punch and die. It also provides for more uniform front-to-back pressure for bottom forming and flattening work. Bed openings, spaces between uprights and throat depths are all larger, and press crankshafts are unusually large. On larger presses there is longer slide adjustment. All gears are 3 degree helical. Another feature of these presses is a portable inclining mechanism of either worm gear or ratchet type. This inclining mechanism allows a press user to buy a single inclining mechanism for a whole battery of presses. Press controls fit into a box only 14 inches wide and 18 inches high. Presses are available with two clutch types, air friction and mechanical. They can be equipped with either double roll feeds (shown), single roll feeds, dial feeds, or special feed designs. **E. W. Bliss Co.**, 1375 Raff Rd., Canton, Ohio.

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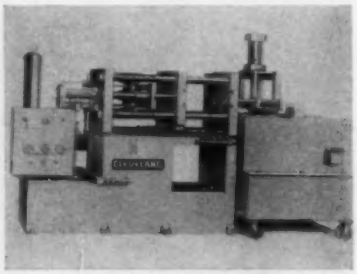
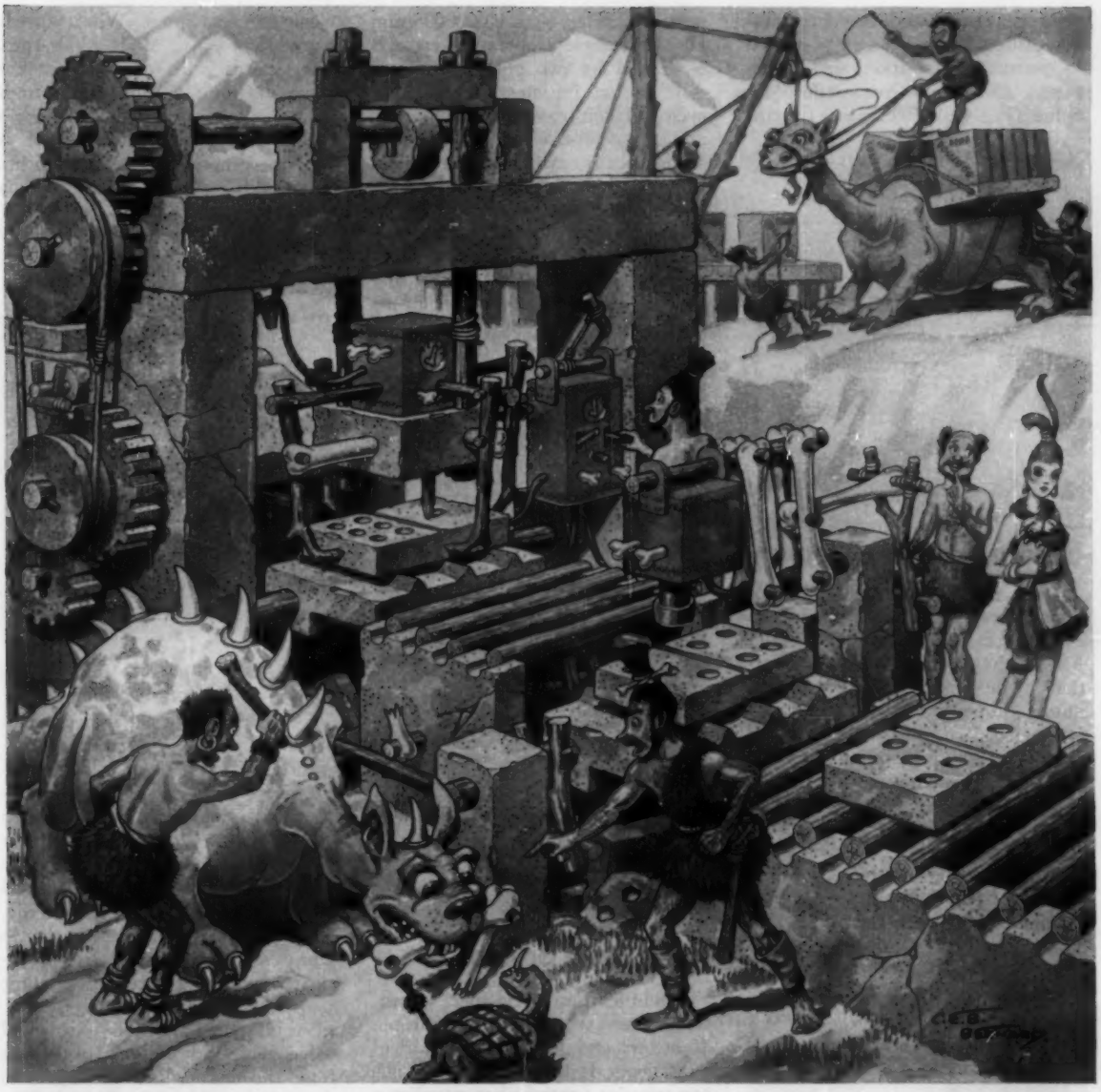


Die Casting Machine

This machine has strain gage tested locking pressure of better than 100 tons, and is available as a standard, or fully automated, hot chamber machine; as a standard cold chamber machine; or as a cold chamber machine equipped with a system of vacuum die evacuation, with or without automatic aluminum ladling. Model 100 is equipped for accumulator operation of both shot and die closing cylinders, and cycles well over 1000 shots per hour, depending upon size and complexity of casting, the metal being cast, and the method of operation. It has a shot capacity of 2.6 lb aluminum and 4.2 lb zinc with standard plungers (other capacities with other size plungers). The machine has 22 by 23 inch die plates and can accommodate dies of 19 inches maximum and 4 inches minimum thickness. Platens are 3¾ inches thick and tie bars are 2½ inches in diameter. The machine is equipped with a 15-hp motor, driving a pump having a capacity of 22 gallons per minute at 1000 lb pressure. A 60-gallon hydraulic fluid reservoir and a 7½-gallon piston-type accumulator are provided. This machine is designed with the toggle mechanism in the horizontal plane for greater accessibility. Its main control panel is mounted at the pump end of the machine. The furnace is mounted on casters so that it can be rolled away from the machine to remove the pot from



Eloquent testimony to man's perennial automating instinct, this is the Awesomely Automatic Domino Inspector (Anno Domino 27,700 B.C.) Part of a special pictorial history of automation by Barkley & Dexter.

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This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

You should know more about B & D. Here is what our service consists of:

PLANNING — we determine if mechanization can help you; where it can help you; how it can help you; how much it is likely to cost; how much it will save.

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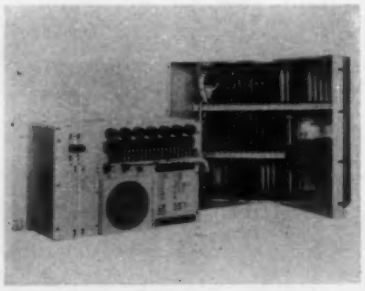
50 FRANKFORT STREET, FITCHBURG, MASSACHUSETTS—*Pioneers in Automation*

the furnace. For hot or cold chamber casting the machine is designed to permit two-position shot injection. **Cleveland Automatic Machine Co.**, 4932 Beech St., Cincinnati 12, Ohio.

Circle 425 on Page 19



General Purpose Memory

Units may be operated in a random access mode, as sequential access buffers, or any combination of both without loss of speed. Applications include small digital computers, automatic control, data editing and format revision, automatic checkout programming, and automatic large scale computer testing. Designated Model RB, these memory devices provide asynchronous operation at rates to 200 kc and are available in capacities from 128 to 1024 words with word lengths from 4 to 24 bits. **Telemeter Magnetics Inc.**, P. O. Box 329, Culver City, Calif.

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Vacuum Station

High-vacuum pumping station is capable of achieving pump-down to 0.000005 mm Hg in less than 35 seconds, blanked port, and ultimate pressures of less than 0.0000005 mm Hg. Its complete operating cycle is controlled by two pushbuttons. A start button initiates the roughing cycle. Upon reaching a predetermined pressure setting, a controller automatically switches the valves from roughing to high-vacuum position. The front panel of Model VS-401 has an operating schematic diagram with signal lamps, indicating the valves actuated during any part of the cycle. Housed in its modern compact cabinet is a stainless steel high-speed oil diffusion pump and pneumatically operated four-inch high vacuum valve, nickel plated baffle, low-loss liquid nitrogen cold trap and complete roughing and fore-line asembly. **Veeco Vacuum Corp.**, Dept. 77, Terminal Drive, Plainview, N. Y.

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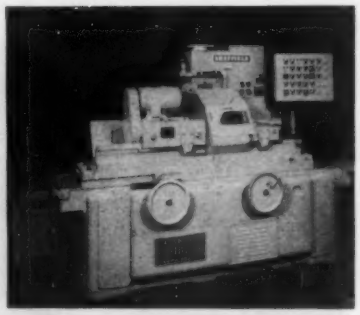

Multi-Form Grinder

Machine uses a 4½-inch Crushtrue dressed wheel to grind multiple diameters and forms on cylindrical workpieces. It is equipped with automatic size control that supplies a signal to retract the wheelhead at final size. Model 181 features a variable speed control for automatic fast and slow feed of the wheel into the work and an automatic plunge grinding device with 1-inch rapid approach and retraction of the wheel. The wheel has cam controlled feed of 0.250 inch with dwell time variable. Other features include: Swivel type worktable, table locking device, and control lubrication system for all ways and annular table positioning device. Length of work between centers is 24 inches maximum, and work diameter is 10 inches maximum. Longitudinal adjustment is 24 inches. Table swivel is clockwise 10 degrees, and counterclockwise 5 degrees. Wheel speeds are 1150, 1270, and 1390 rpm. Workspeeds with dead center are 47 to 760 rpm; with live center from 95 to 1440 rpm. Wheelhead feed is 0.500 maximum, and its motor is 1⅓ hp. Wheelhead motor is 15 hp. **Sheffield Corp., Subsidiary, Bendix Corp.**, Dayton 1, Ohio.

Circle 428 on Page 19

Valve Operation Analyzer

Device for the exact measurement of time intervals in sequential operations of solenoid or relay-actuated components or systems provides "position-versus-time" plots for such operations as linear or nonlinear valve motion. It measures time intervals as short as 0.1 millisecond and presents the readings visually, in printed form and graphically. As many as 12 sequential events occurring within a three-second time span can be automatically timed. In timing operation of a solenoid valve, the analyzer gets its signals from the discontinuity in electrical wave form caused by energization (or de-energization) of the solenoid and by completion of solenoid travel. In timing hydraulically or pneumatically operated valves, limit switches marking the extremes of valve travel provide timing signals. Operation with relays involves detection of coil energization and closure of contacts. For plotting "position-versus-time" curves of valve operation, useful in bench testing and adjusting, standardized transducer adapter plates can be substituted for normal valve plates. The unit operates from 115 volt, 60 cycle ac. **Consolidated Avionics Corp.**, 800 Shames Drive, Westbury, N. Y.

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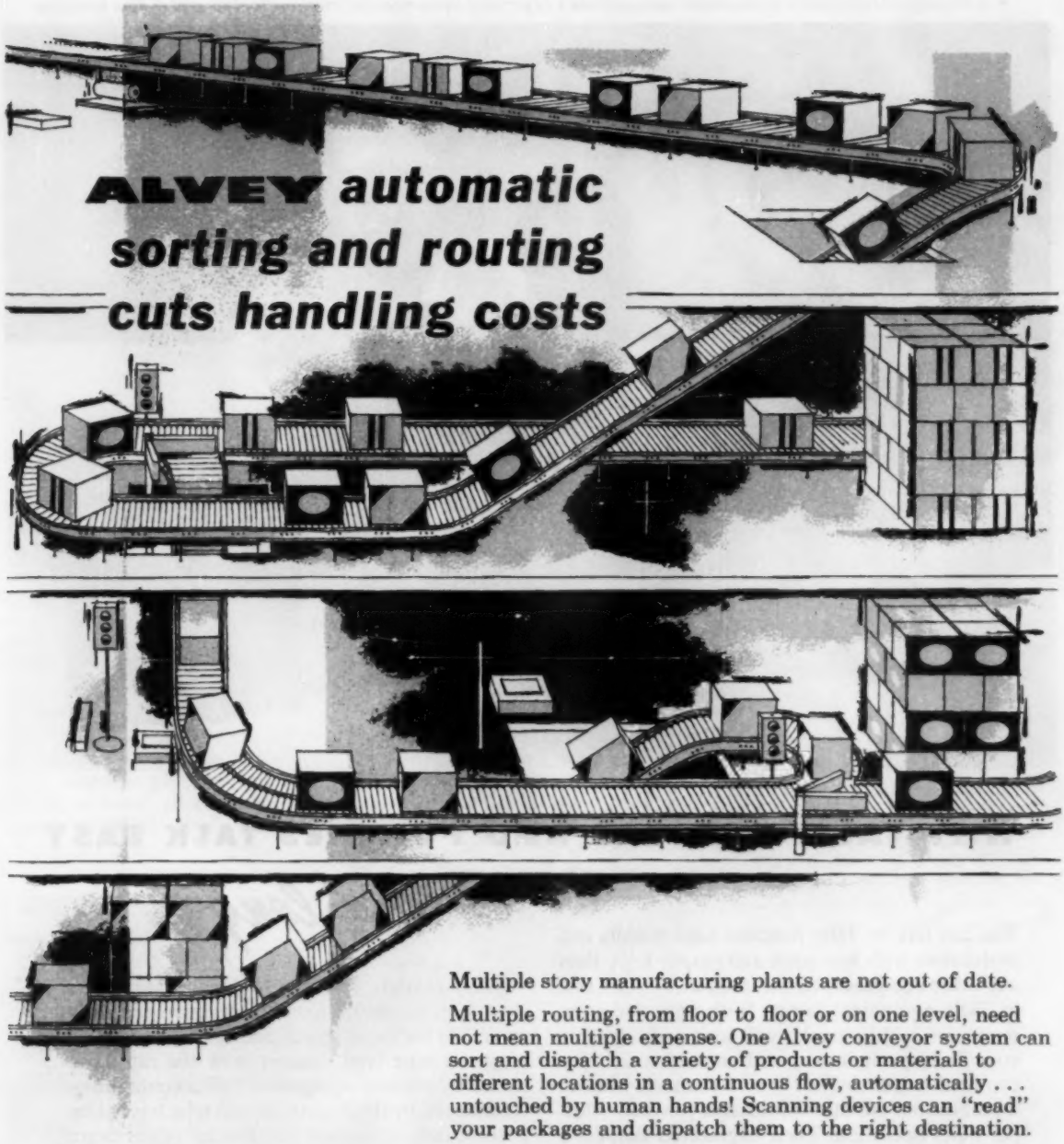

ALVEY automatic sorting and routing cuts handling costs

Multiple story manufacturing plants are not out of date.

Multiple routing, from floor to floor or on one level, need not mean multiple expense. One Alvey conveyor system can sort and dispatch a variety of products or materials to different locations in a continuous flow, automatically . . . untouched by human hands! Scanning devices can "read" your packages and dispatch them to the right destination.

Whether you need a completely-integrated conveyor system, or individual package handling units, put Alvey's experienced, creative conveyor engineering to work for you.

If you're planning to build, modernize—or if you're simply open to new ideas—call in Alvey. No obligation for consultation. **Alvey Conveyor Manufacturing Co., 9373 Olive Street Road, St. Louis 32, Mo.**

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Royal McBee Corp.	A.C.F.Wrigley
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Firestone	Esso Standard Oil

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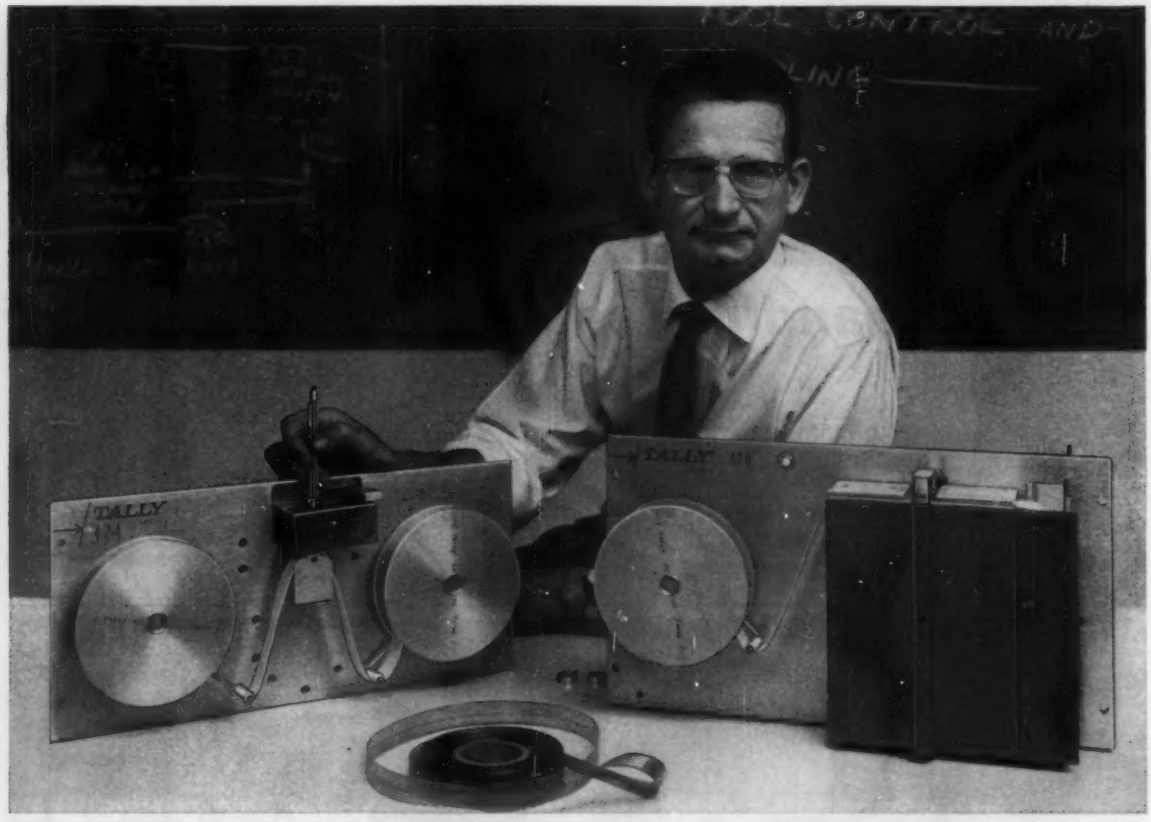
ROLLER, BELT, APRON, PUSHER BAR, SPIRAL, AND SLAT CONVEYORS • PACKAGE HANDLING SPECIALTIES

Circle 701 on Page 19

• *A message of importance to engineers using punched paper tape equipment for machine tool control & data handling*



WHY TALLY READERS AND PUNCHES TALK EASY

You can talk to Tally punched tape readers and perforators with less input and output logic than any other equipment on the market. You can talk to Tally equipment faster. With only one command, your Tally reader will read and advance; your Tally perforator, punch and advance. You can read or punch 5, 6, 7, or 8 channels without modification. Oil mist lubrication provides whisper quiet operation. Their engineered simplicity means long term reliability.

Tally perforators operate *asynchronously* at any rate up to 60 characters per second. Their unique wire clutch drive lets you vary speed for slaving to other equipment, simplifying design of logical systems. Prices for perforators start at $1,000.

P.S. Problems in making complex programming tapes? Call us, we're making 4 to 16 channel guaranteed error-free punched tapes for many missile and satellite programs.

...and long

Tally readers feature a reading rate of 60 characters per second in either direction, instantly reversible for rapid search and select. They have triggered tape feed readout with the rate controlled by external equipment. Full accountability is furnished by the Form C switch which provides positive hole/space sensing. Reader prices begin at $595.

Special Tape Systems Available

On request, Tally engineers will be happy to review your product requirements for special tape readers, perforators and reader-perforator systems. Please address Dept. 06.

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Seattle, Washington
Phone: MAin 4-0760

7

AUTOMATION new components

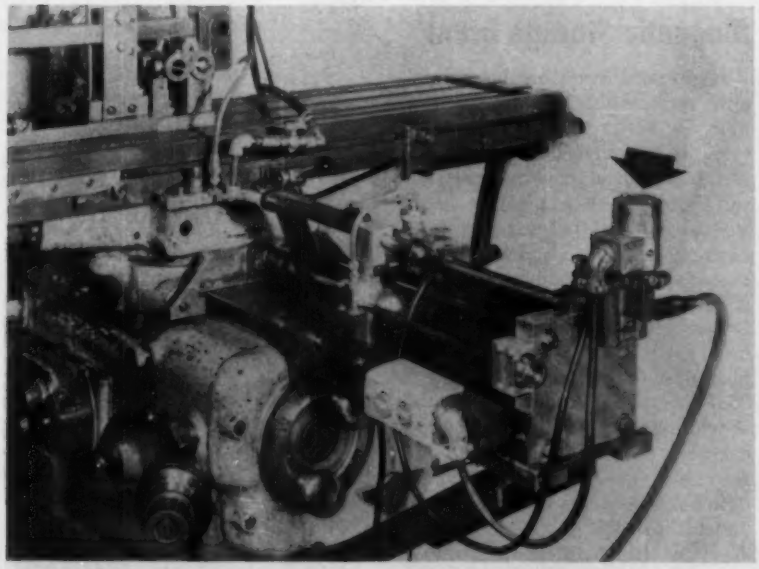
Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.

Circuit Holder Solenoid Valve

FOUR-WAY valve with a built-in circuit holder is designed to simplify wiring by eliminating the need for relays and relay circuits. Developed by the **Control Valve Div., Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif., it may be used to control cylinder action on a multitude of tooling setups where reciprocating motions are involved. Illustration shows the valve installed on a milling machine which is set up for a boring operation on a bronze casting. Valves are available in three types: Type AHR, internal pilot supply; Type AHOR, external pilot supply; and Type AHON2R, dual pressure. Types AHR and AHOR can be obtained with an integral sub-base to meet mounting requirements. All models are available in ¼, ⅜, ½, and ¾-inch sizes. Standard voltages are as follows: 24, 115, 230, 460, or 550 volts, 60 cycles ac; 115 or 230 volts, 25 cycles; 115 or 230 volts, 30 cycles; 115, 230, or 460 volts, 50 cycles; 6, 12, or 24 volts dc. Valves with other voltages and frequencies are obtainable. The circuit holder consists of contacts that are closed with actuation of the solenoid that also operates the valve. When connected in a circuit with other devices, such as limit switches, the circuit holder feature enables the solenoid operated valve to maintain its operated position. For example, a typical application might be the repetitive cycling of a pneumatic cylinder under control of the valve in conjunction with two limit switches that indicate whether or not the cylinder rod is in an extended or retracted position. In this typical application, the circuit holder contacts can be connected such that a circuit is maintained through the solenoid even though one of the limit-switches necessary to originally making of the circuit drops out as the cylinder rod begins to move from its retracted position. The second limit switch is so connected that the circuit to the circuit holder contacts is broken with the desired extension of the cylinder rod, enabling the solenoid to assume its unoperated state and position the valve so as to retract the piston rod.

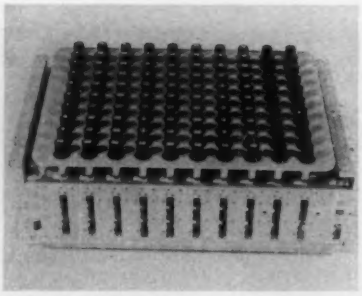
Circle 430 on Page 19



Solenoid valve (arrow) is installed on a milling machine which is set up for a boring operation on a bronze casting. Heavy-duty solenoid is provided to operate valve and circuit holder contacts. Circuit holder feature of the unit can reduce requirements for relays in control circuits.

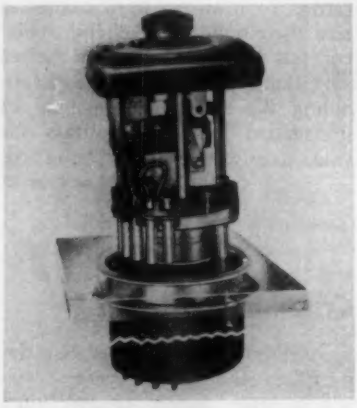
Crossbar Switch

Pushbutton crossbar switch is designed to eliminate necessity of wiring a large matrix of individual switches and to replace conventional patchcord switching. It can handle anything from the microvolt dc signal of a thermocouple to the megacycle signals of radar. A constant characteristic impedance throughout the switch of 75 ohms and the ability to handle high frequency signals makes it useful in radar and color television applications. Noise induced in the contacts from the actuators is less than five microvolts and thermoelectric noise less than 0.01 microvolt/deg C. The switch can therefore be used with very low level thermocouple and strain gage



signals. Breakdown voltage between switching conductors and the frame and across switch contacts is 1000 vac. With special constructions, this can be increased to 2500 vac. Insulation resistance from conductors to frame and between conductors runs as high as 1,000,000 megohms. Contact resistance of the twin gold contacts is between 10 and 20 milliohms. Conductor resistance through the longest path is 0.3 ohm and the contacts will carry up to 3 amps. Crosstalk is −60 db at 10 mc with a 100 ohm termination. **James Cunningham Son & Co. Inc.**, P. O. Box 516 Zone 2, Rochester 8, N. Y.

Circle 431 on Page 19



Dial Timer

Suitable for industrial processing operations in which downtime on high production machines is extremely costly, this plug-in dial timer employs a keyed guide-pin for maximum safety and convenience. This pin, which properly aligns the timer in the case, protrudes through the rear of the plug-in terminal block on the housing, and is drilled to take a snap-in cotter pin clip. In addition to providing a means of secure engagement this feature offers a safety precaution without impeding quick removal and replacement. The timer is available for ac or dc operation. Dial ranges from 15 seconds to 60 hours are available for 115 volts 60 cycle current, and dial ranges of 30 seconds to 240 minutes are available for 48, 125, and 250 vdc. Ac rating of 115 volts 50 cycles; 115 volts 25 cycles; 230 volts 50 cycles; 230 volts 25 cycles; and 230 volts 60 cycles are available. Optional dc voltages of 28 and 32 vdc are also available. For maximum flexibility a front mounting clamp is available for applications where rear accessibility is not feasible. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

Circle 432 on Page 19

Magnetic Storage Drum

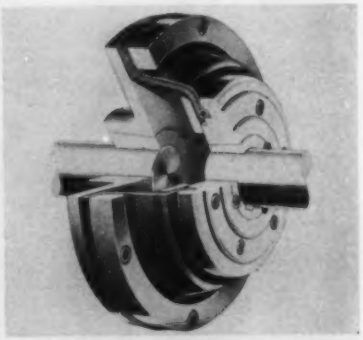
High-speed drum has been developed to meet the exacting specifications for buffer storage to magnetic tape. It is designed for long life in severe industrial environments and can be used as a medium access storage for data reduction or processing systems and similar applications. The application versatility of the Farrington magnetic drum is provided by the pulley and belt drive, which is readily replaceable to provide speeds up to 25,000 rpm. The drum is capable of storing 100,000 binary bits of computer information. The optional matching circuitry for electronic switching, reading, and writing on desired tracks is supplied in blocks of 10 or 16 channels and consists of one printed circuit read-write board per track. It is designed to permit operation up to 500 kc, with input and output levels of +5v and −5v, respectively, for a one and a zero. Where both drum and electronics are supplied, modular construction is used. **Brogan Associates**, Mineola, L. I., N. Y.

Circle 433 on Page 19

Twin Triode

High-gain twin triode with true frame-grid construction offers high reliability for instrumentation, industrial controls, nuclear electronics, communications, and broadcast equipment and TV tuners. Model ECC88/6DJ8 features a trouble-free coil heater. Its grid has superior mechanical strength supplied by a welded molybdenum frame and superior electrical characteristics resulting from tightly wound, precisely positioned fine tungsten wire. **CBS Electronics, Div., Columbia Broadcasting System Inc.**, Information Services, 100 Endicott St., Danvers, Mass.

Circle 434 on Page 19

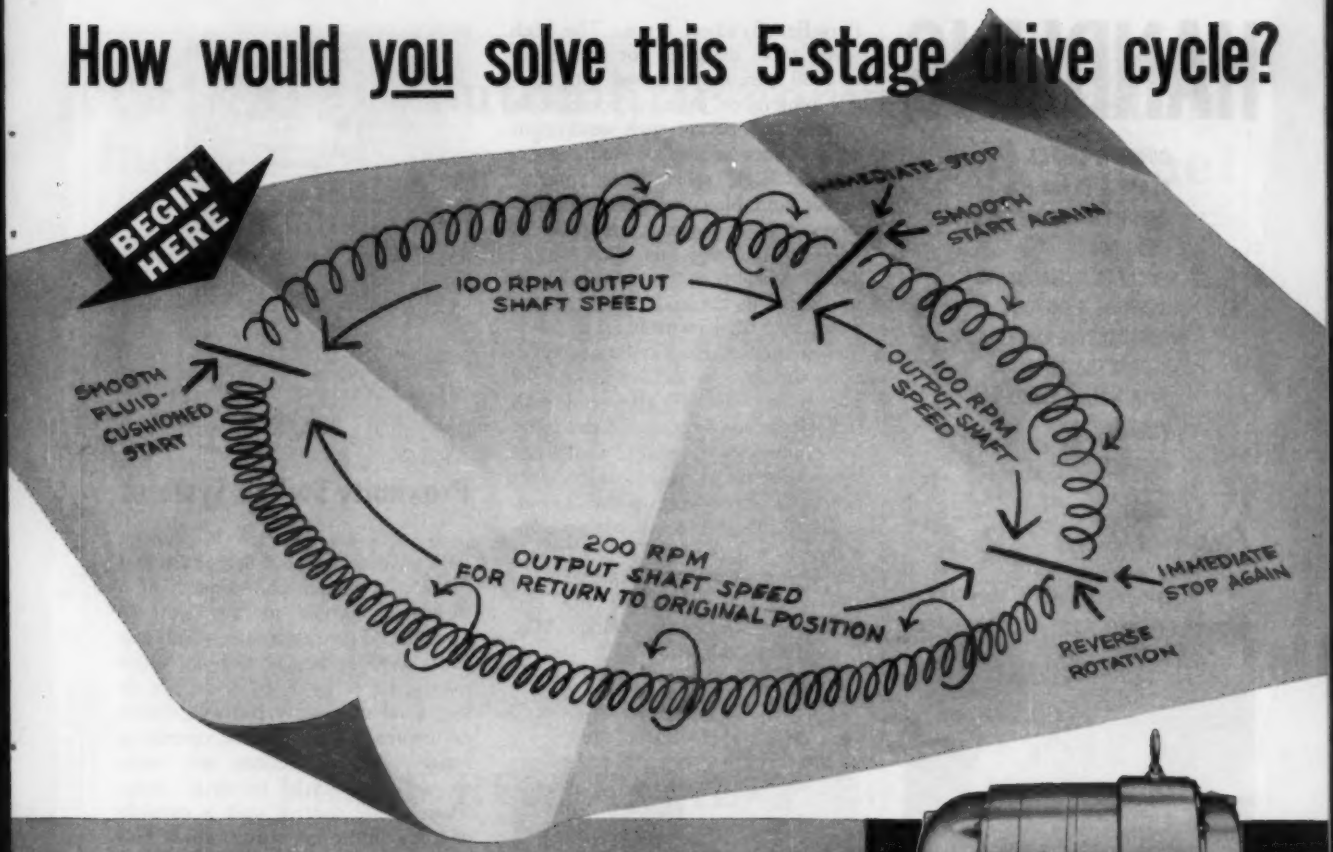


Cushion Couplings

Flexible cushion couplings have been developed for high-speed or high-torque applications. They feature a pan-shaped rubber flexing element and are designated as Paraflex high speed (illustrated) and

Circle 703 on Page 19→

How would you solve this 5-stage drive cycle?



This one *modern* Reuland power package *does* all five!

Today's ingenous, automatic machines have demanded a whole new concept in electric motors. No longer will "just any motor do" because the motor now becomes merely an integral part of the modern drive *package*.

Reuland's "Xpandable Design" idea *originated* this modern new approach several years ago. With this unique system, drives incorporating many varied factors are supplied as a single unit . . . *tailored to the needs of each individual customer*.

Modern Reuland Power demonstrates every day that there *is* something new in electric motors. Whether *your* own drive needs are more complicated, or less, than the above sketch . . . it will pay you to take stock and compare with what Reuland can offer.

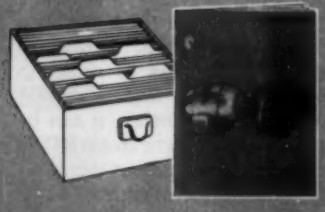
MODERN REULAND POWER

This unit contains an internal fluid coupling . . . a two-speed reversing duty motor . . . gear reducer . . . and magnetic brake mounted between the reducer and the fluid coupling. It is typical of the literally hundreds and hundreds of tailored adaptations available as a result of Reuland's modern "Xpandable Design" idea.

It is easy to see how this one, compact drive package saves costs and space and weight in comparison to installing separate drive units.

Our New General Catalog Will Come In Handy — Sent FREE On Request

Gives details on Reuland's "Xpandable Design" . . . also shows how O.E.M.'s save money by using Reuland's free "Special Motor Library." Get a copy for your files now, for sure.



MODERN POWER FOR MODERN-DAY PRODUCTS

REULAND MOTORS

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EASTERN DIVISION: Howell, Michigan
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Refer To Sweet's Product Design File, Section 5a

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RADIOACTIVE MATERIALS
REFRACTORIES
THIN WALL CYLINDERS

P

Pneuma-Grip®

A new concept in critical Materials Handling

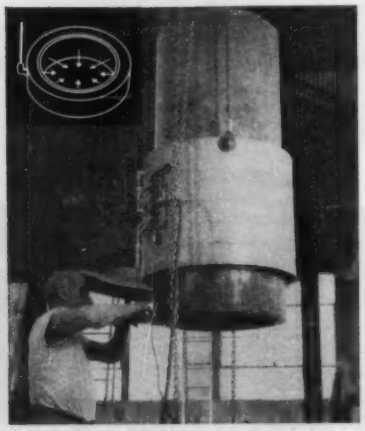


Photo courtesy Frenchtown Porcelain Co.

Controlled air pressure provides a holding method unparalleled in effective critical handling problems. Pneuma-Grip's contact face of air actuated rubber members can grip fragile thin wall or micro smooth surfaced materials regardless of weight or configuration, without adverse effect or change on the structure. Used in conjunction with conventional lift, hoist, handling equipment, Pneuma-Grip is today's answer to critical handling problems. *U.S. Patent No. 2,894,780

For 8-page descriptive catalog write:

PR

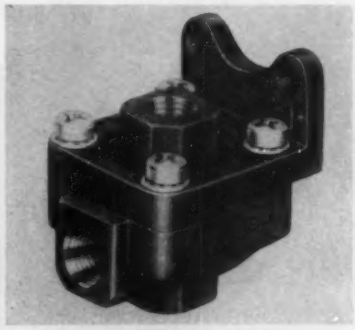
THE PRESRAY CORP.
PAWLING, N.Y.

Also manufacturers of Pneuma-Seal for critical sealing problems

Circle 704 on Page 19

Para-flex flywheel types. The high speed type, designed for speeds up to 5230 rpm, may be used with electric motors or internal combustion engines to operate such equipment as hammer mills, compressors, pumps, high speed fans, marine drives, and blowers. They are efficient on low-speed applications where torque requirements are high. The flywheel type coupling is offered in sizes to fit the bolt circles of most standard SAE flywheels up to 19¼-inch diameter. Both types are available in sizes to deliver up to 47 horsepower per 100 rpm and with taper-lock bushings to fit shafts up to 4 inches in diameter. Hubs can be ordered bored to size to fit larger shafts. These couplings can accommodate, either singly or in any combination, angular and parallel shaft misalignment and end float, can absorb torsional vibration, and can cushion shock loads. **Dodge Mfg. Co.**, Mishawaka, Ind.

Circle 435 on Page 19



Electric Vibrator

Device is suitable for applications such as vibrating tables, feeders, screens, chutes, or for problems best solved through the use of directed force. Model ET-31 dual shaft electric vibrator develops a directed force vector through the use of two eccentrically weighted armature shafts geared together to rotate in opposite directions. Equipped with four adjustable eccentrics, it can be set to produce impacts from 760 to 2200 lb at 3600 vibrations per minute. Available for operation on 3-phase, 60 cycles, 220 or 440 volt, it is normally supplied with a starter box. Special mounting brackets are available. **Vibro-Plus Products Inc.**, Stanhope, N. J.

Circle 436 on Page 19

Proximity Switch Systems

Systems are capable of sensing both nonferrous and ferrous metal parts. An installation consists of a pickup (mounted at the point of work), and a control unit which can be housed in any wiring enclosure measuring 6 by 8 by 4 inches or larger. A sensitivity control permits adjustment to the desired operating range. All connections are made to a barrier-type terminal strip. Model 4902 control unit is capable of a maximum operating rate of 600 operations per minute. It will respond to any metal part that remains within range of the pickup for 50 milliseconds or more. Input is 117 volts, 50/60 cycles ac at 15 watts; 230 volts optional. Output consists of SPDT relay, contacts rated at 5 amps, noninductive. **Electro Products Laboratories Inc.**, 4500 N. Ravenswood Ave., Chicago 40, Ill.

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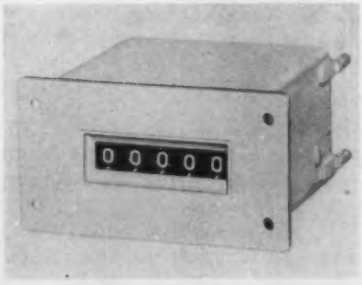
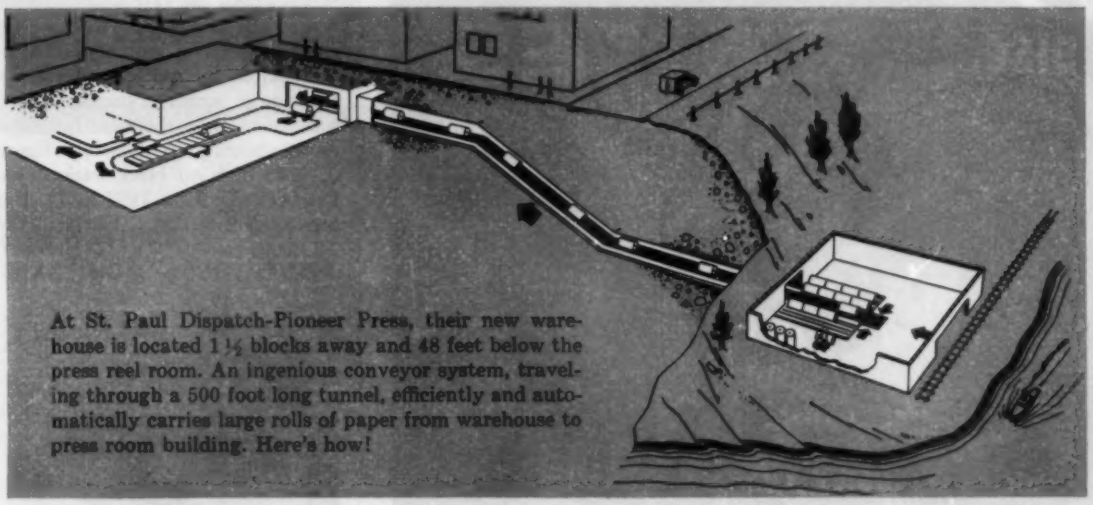


Sealed Counter

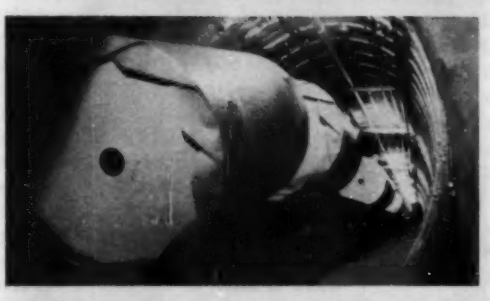
Hermetically sealed electric counter with electric instant reset is designed specifically to meet MIL specifications 3272-A. It is being used

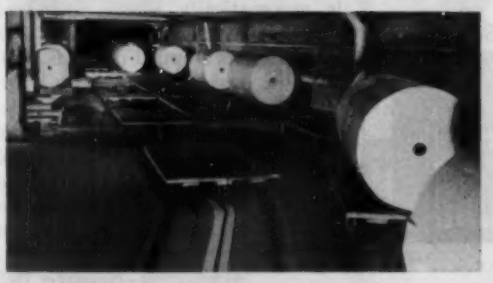
This Webb automatic conveyor system hustles newsprint thru 500 foot tunnel



At St. Paul Dispatch-Pioneer Press, their new warehouse is located 1½ blocks away and 48 feet below the press reel room. An ingenious conveyor system, traveling through a 500 foot long tunnel, efficiently and automatically carries large rolls of paper from warehouse to press room building. Here's how!

ROLLS REALLY KEEP ROLLING





1. At warehouse, the newsprint rolls (60" long x 36" in diameter and weighing 1500 lbs.) are removed from railroad cars by lift trucks and stacked for storage or placed on the tunnel conveyor for current use. Systematic loading of conveyor is accomplished by two sets of kicker plates which operate in series to propel four rolls at a time into spaced positions on the conveyor. Kicker plates are actuated by bumper switches and air pressure.

2. Tunnel conveyor is divided into four individually powered sections which can be operated "continuous-run" or separately for programming. The ascending section is built on a 15-degree incline and its slats are rubber coated to preclude slipping of load. A continuous live-supply of rolls (spaced 18 inches apart) is maintained by means of electric eye controls at beginning and end of each section.

3. When rolls reach the press room basement, they are automatically pushed off the tunnel conveyor and onto Towveyor trucks. Thirty-one of these trucks are attached to a moving chain loop in the floor to provide additional live-storage of rolls. In the reel room area, a semi-automatic "kick-off" pushes the rolls from the Towveyor trucks onto press room trucks as needed.

System capacity is 130 rolls, manual handling is eliminated, live and stationary storage is provided, and high efficiency is assured by the soundly engineered solution of this unusual material handling problem.

Circle 705 on Page 19

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DISC BRAKES

(THE CHOICE OF LEADING MOTOR MANUFACTURERS)

Stearns Style "H" Motor-mounted Brake as used on each of the four spindle drive motors.

. . . are used on this KEARNEY & TRECKER SPECIAL PRODUCTION MACHINE TOOL THAT

BOOSTS OUTPUT 400%

This *Kearney & Trecker* special production machine tool bores four holes in engine blocks simultaneously . . . replaces a single hole per setup, horizontal milling and boring machine. Interchangeable inserts allow operations on any of four different size engine blocks.

Just as *Kearney & Trecker* solves special machining problems to boost production in any industry . . . so *Stearns* has, for over 40 years, solved requirements for multiple disc Brakes (and Clutches) for the steel, cement, food, chemical, textile, cement, machine tool, press, and other industries. Advantage-Features such as: fast, smooth, failsafe, quiet stops . . . longer life . . . adjustable torque . . . visual indication of friction lining wear (exclusive) . . . availability, prompt delivery . . . faster, easier, less costly installation and maintenance — are all assured by Stearns. The only brakes where a screwdriver is a complete maintenance tool kit!

For Superior Performance on ANY Machine . . . Specify Stearns!

Stearns ELECTRIC CORPORATION
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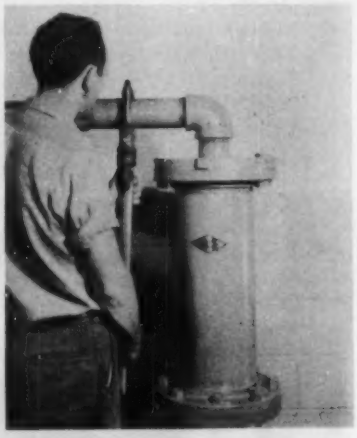
THE COMPLETE LINE OF CLUTCHES BRAKES CLUTCH-BRAKES

Circle 706 on Page 19

in industrial applications where severe atmospheric conditions prevail, and where explosion-proof units are needed. Model 5-YE-9156-ER is a high-speed unit running to 2400 cpm, or 40 cps in standard units, and resetting electrically in 105 milliseconds. It can operate under water, and is complete with a Winchester hermetic seal connector on the bottom for quick connection to the power source. Number wheels are set high in the case for maximum visibility, with white figures $\frac{1}{8}$ inch high on black background. **Durant Mfg. Co.**, 1997-IS N. Buffum St., Milwaukee 1, Wis.

Circle 438 on Page 19



Flow Classifier

Designed for vertical in-line installation in any process piping, gas/liquid flow classifier permits passage of liquids while preventing the passage of gasses. It is ideally suited for use in any processing system where transfer of fluids under pressure is involved. These units may be used in modification applications as well as original ones. Through its mechanical arrangement, the flow classifier valving remains open for full flow, with negligible pressure drop, as long as there is fluid in the line; the valve is automatically closed and held closed under a pressure seal as soon as the line is emptied of fluid. This prevents inadvertent pressure blowback of air or gas through the process fluid. The undesirable liquid eruption and splashing associated with such blowback is avoided and makes it possible to use air or gas pressure for transfer of acids or

NEW

Gardner-Denver "Airfeedrill"® with "aircheck" feed control

Check these "aircheck" features

- √ Low initial investment . . . simple to maintain . . . economical to use
- √ In-line hose arrangement
- √ High-speed feed with slow break-through for clean holes
- √ Closer center-to-center mounting
- √ Short over-all length
- √ Develops full ⅓ hp

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simple, easy, low-cost automation of many drilling setups

Now it's easy and inexpensive to automate drilling such materials as plastics, wood, aluminum, steel, cast iron and sheet metal. Engineer an automatic drilling setup with new Gardner-Denver "Airfeedrills" with "aircheck" feed control.

These versatile new drills are easily adaptable to almost any drilling setup. You mount them as a drilling unit of two, 20 or more spindles for automatic hole processing. Use one as a stationary drill mounted on an inexpensive fixture. As a portable drill, "Airfeedrill" hangs by its nose to a jig for precision drilling.

See for yourself how quickly and inexpensively you can automate *your* drilling operations . . . see your Gardner-Denver representative or write for Bulletin 92-121.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

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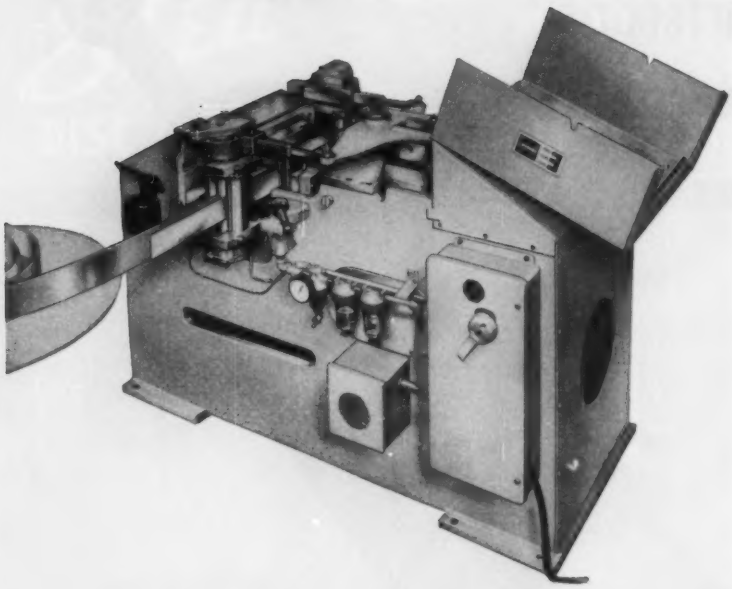
Circle 707 on Page 19

so fast...



...you may not believe it!

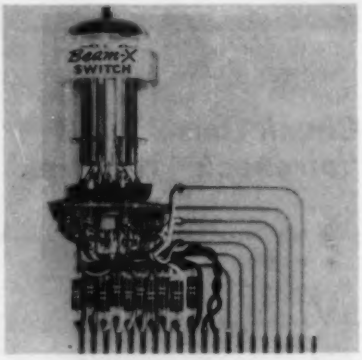
At 1500 strokes a minute — maybe better — this new Emhart press zips open a fresh, exciting page in metal fabrication. And in non-metallic fabricating, as well. We have the feed to go with this super-speed, too, plus the experience to help you realize the full potential of this press. The dramatic — and believable — details are yours for the asking.
EMHART MANUFACTURING COMPANY,
HUDSON DIVISION, HUDSON, N. Y.

EMHART

Circle 708 on Page 19

volatile liquids. Series PMABB classifiers are available in three sizes: Model 200 fits 2-inch nominal pipe diameter; Model 300 fits 3-inch nominal pipe diameter, and Model 400 fits 4-inch nominal pipe diameter. **Prenco Manufacturing Co.**, 2605 W. 14 Mile Rd., Royal Oak, Mich.

Circle 439 on Page 19



Electronic Counter

Miniature decade counter module combines the Beam-X switch, Model BX-1000, with transistors in a circuit capable of resolving pulses at 110 kc. Electrical outputs are provided to operate remote Nixie indicator tubes and printers, and to perform other circuit functions. Model DC-111 has been designed for use in computers, electronic counters, machine control, and similar types of automatic equipment. The units may be directly cascaded and can be driven by a 12 v signal. Total power consumption of the unit is only two watts. **Electronic Tube Div., Burroughs Corp.**, P. O. Box 1226, Plainfield, N. J.

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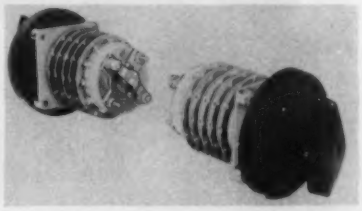
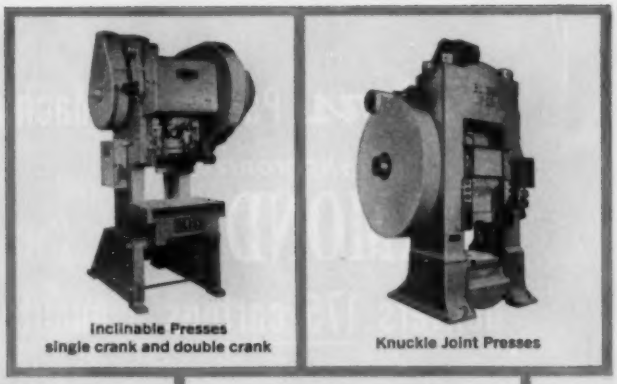


Rotary Switch

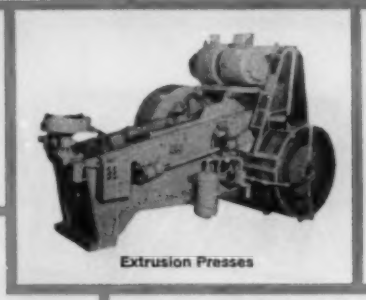
Compact unit provides single-knob control of as many as 75 poles per switch. It is available in any

Why do more people buy BLISS presses than any other make?



Inclinable Presses
single crank and double crank

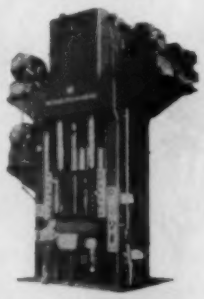
Knuckle Joint Presses



Extrusion Presses

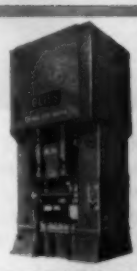
Eccentric Presses

Rolling Bolster Presses



Hydro-Dynamic Presses

High Production Presses



Toggle Drawing Presses

(they do, and have for a long, long time)

No matter what kind of press suits a particular job best, Bliss can supply it.

And Bliss engineers' many years of experience is a valuable plus when it comes to recommending the right press. Straightside, inclinable, high-production, toggle, overdrive, underdrive, hydraulic—Bliss builds them all; grinds no axe for any one type.

But above these advantages . . . above Bliss engineering counsel and the vast Bliss parts and service organization that blankets the country . . . is the century-old Bliss tradition of quality and reliability.

"Bliss is more than a name . . . it's a guarantee" is more than a combination of nice-sounding words. It's a simple statement of fact.

BLISS
SINCE 1857

E. W. BLISS COMPANY · Canton, Ohio

BLISS is more than a name—it's a guarantee

PRESSES • ROLLING MILLS • ROLLS • DIE SETS • CONTAINER MACHINERY • CONTRACT MFG. • PUBLIC SAFETY

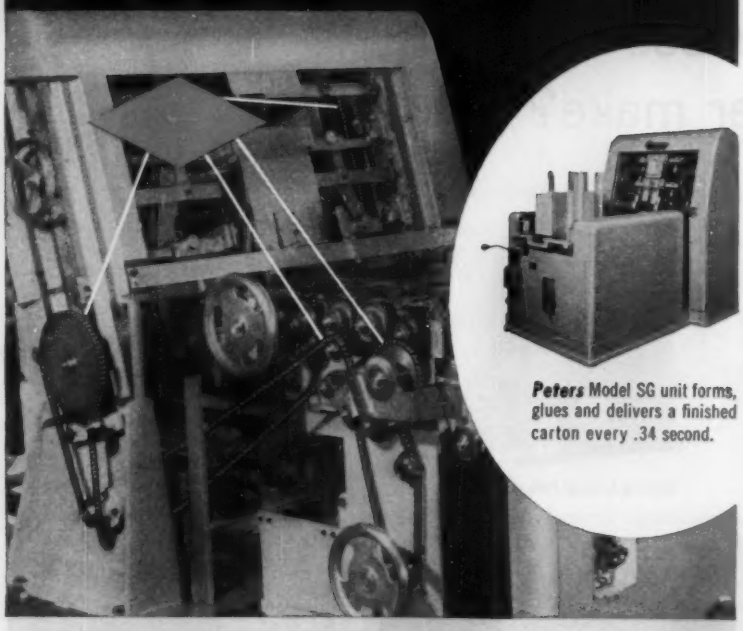
Circle 709 on Page 19

Peters Packaging Machine

synchronized by

DIAMOND Roller Chain

delivers 175 cartons a minute



Peters Model SG unit forms, glues and delivers a finished carton every .34 second.

A small error in split-second timing could cause a monumental snarl of cartons, glue and machine parts. To insure *precise synchronization* and dependable, trouble-free performance, Peters Machinery Company, Chicago, Illinois, specifies DIAMOND Roller Chain for high-speed packaging equipment.

The proven strength, durability and high dimensional accuracy of DIAMOND Roller Chain offer many opportunities to improve and simplify machine design . . . to solve conveying, timing and power transmission problems.

Write for catalog containing complete information on DIAMOND Roller Chain and Sprockets. Engineering assistance is available.

DIAMOND CHAIN COMPANY, INC.

A Subsidiary of American Steel Foundries

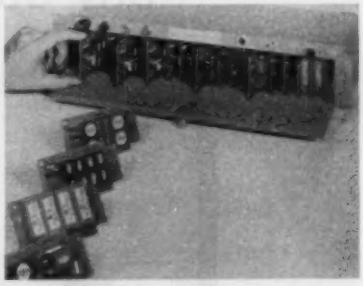
Dept. 412 • 402 Kentucky Ave., Indianapolis 7, Indiana

Offices and Distributors in all Principal Cities

DIAMOND ROLLER CHAINS ®

number of sections from 1 to 25, and with a wide variety of contact arrangements. This Model JM rotary multipole switch is suited to complex-circuit controls as well as to tap, transfer, and selector service. Sturdy detent action gives positive positioning at 30-degree intervals. Switching action, which may be shorting or nonshorting, is wholly contained within the insulated enclosure formed by the molded section-elements. Switch has an interrupting rating of 5 amperes 125 volts ac at unity power factor. **Electro Switch Corp.**, King Ave., Weymouth, (Boston 88), Mass.

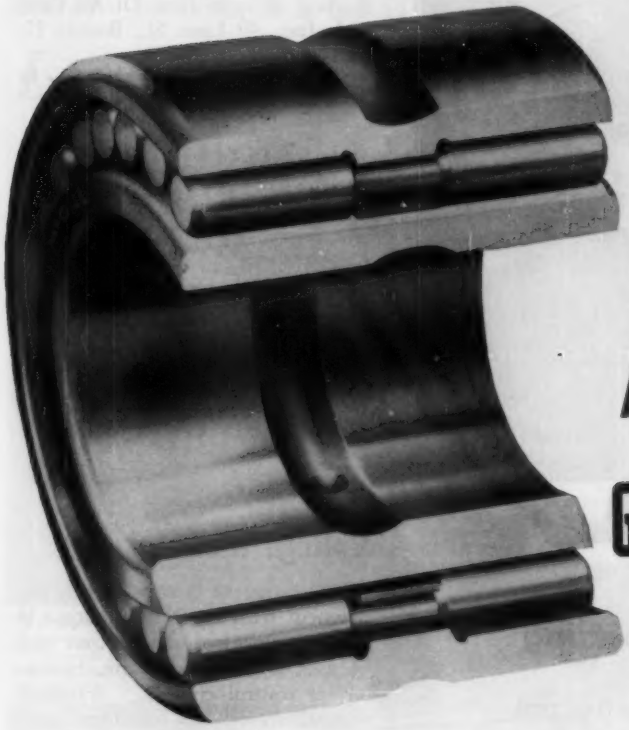
Circle 441 on Page 19



Buffer Storage Systems

Buffer product line has been redesigned to provide a compact, rugged series of digital storage systems with storage capacities from 36 to 4032 characters. These storage systems incorporate the use of magnetic logic techniques which have extended the operating margins and life of the units and reduced the number of semiconductor elements. Character loading and unloading time is 5 microseconds, repeat at loading or unloading rate is 100,000 characters per second. Units are available with any number of characters per bit. Stock sizes are up to 12 characters per bit. The systems contain all functional circuits for addressing, driving, writing, sensing, and output flip-flops. The units are available as MIL specifications units meeting the requirements of 16, 4000, or 5148B. There are three types of sequential access memories in this line. One is a general purpose sequential access memory, Model SA-VB-INT, with separate controls and address generators for the load and unload functions. The second model is the SA-IA-INT which provides for the interlaced

FOR EXTRA LOAD CAPACITY IN MINIMUM RADIAL SPACE use



McGILL®

GUIDEROL® BEARINGS

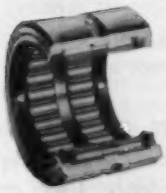
MT SERIES

Here is a compact bearing with high load-carrying capacity. Its full complement of race-width rollers is guided by an integral rail in the outer race bore, providing strength and skewing limitation that prevents binding under controlled misalignment. Rollers are guided at any operational angle from horizontal to vertical — self-cleaning through open ends. Available with or without separate inner ring in shaft sizes from ½" to 9¼". Dimensionally interchangeable with ordinary heavy duty needle bearings.

CT SERIES

Offer full type roller bearing capacity dimensionally interchangeable with ball and cylinder roller bearings of single and double row dimensions. The inner ring may be eliminated for further reduction of radial space.

SEALED—AND STILL COMPACT



No extra axial space needed for the sealed SG series GUIDEROL bearing. Seals are press-fitted securely in the outer race bore to provide the same width and performance advantages of standard GUIDEROL bearings. Contaminants are locked out, lubricants sealed in for those hard to re-lubricate applications. The SG series solves the problem of too-expensive auxiliary sealing assemblies.

Write for McGill's Bearing Catalog #52-A, for engineering data with dimensional and capacity information on McGill needle type roller bearings. Ask about special precision ball and roller bearings.

McGILL MANUFACTURING CO., INC., Bearing Division
401 N. Lafayette Street, Valparaiso, Indiana

engineered electrical products

McGILL®

precision needle roller bearings

with **LIPE**

Automatic Machine Loading

● You can meet and beat competition by getting peak production from every machine in your shop — new *and* old. Lipe Automatic Machine Loading delivers at least 90% of the gross geared capacity of any production machine, because stock is fed continuously. Your machines cut stock — not air!

● Lipe AML Bar Feeds automatically feed stock of practically every length, shape and material, in close-tolerance feedouts. Users report production increases of 40% . . . 90% . . . and even 200% per machine, plus labor benefits that are even more important. Workers are freed from back-breaking hand-loading of stock . . . concentrate on quality and machine set-ups. For a free estimate of what Lipe AML can do for your shop, send prints or samples of typical work. Write for full information.

Stop Cutting Air and You Start Cutting Costs

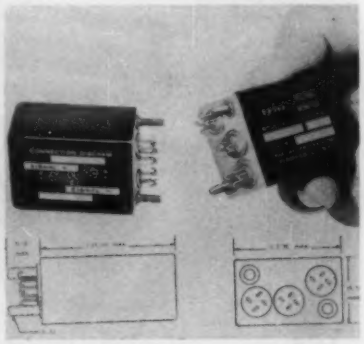
Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 712 on Page 19

unload and load operation address at each address in the memory. The third model is the SA-IB-RESET. This unit is used where a block of data is to be entirely loaded and unloaded before proceeding to the loading of new data. **Di/An Controls Inc.**, 40 Leon St., Boston 15, Mass.

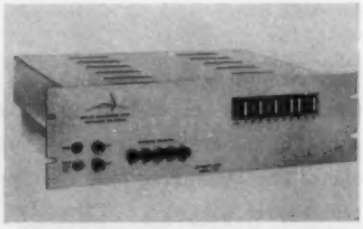
Circle 442 on Page 19



Voltage Monitor

Direct-current voltage sensing instrument with Go/No-Go output is fully-transistorized device that can be used for external alarm, indicator, or control circuits. Standard with all Model 203-1 voltage monitors are *Inhibit* and *Latch* terminals. The *Inhibit* terminal prevents operation of the monitor at selected times without disrupting other connections. The *Latch* terminal, when connected to the *Inhibit* terminal, will lock the normally open contacts in the closed position when the input exceeds the pull-in voltage. **Trio Laboratories Inc.**, Plainview, L. I., N. Y.

Circle 443 on Page 19



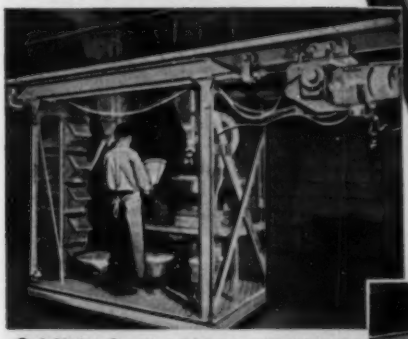
Computing Unit

Series of digital computing units are used in data processing, instrumentation, and control systems

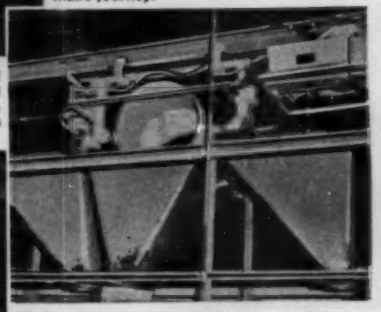
Automation in Action!

Louden Selectomatic Dispatch

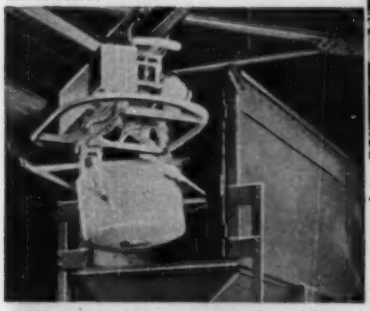
1 A Mixing Operator loads a carrier after electrically calling it on the control panel. After loading, he will select on the panel the carrier's destination and start its automatic journey.



2 A Mixing Operator rides a Louden Weighing Lorry selecting the grades of grits according to type of grinding wheel to be manufactured. Similarly, the various grades of bonding agents are selected.

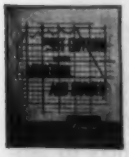


3 Completely unattended, the Louden Selectomatic Carrier stops at a designated press hopper and dumps the mix.



4 After automatically dumping, the carrier proceeds to the cleaning station; opens and shuts doors, starts and stops an air cleaning jet which thoroughly cleans the bucket.

NEW . . . 52 PAGES of illustrated applications . . . industry by industry.



Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."

Automation always brings its greatest gains by the waste it eliminates in *handling*. It saves time and it saves labor; uses men for their brains rather than their brawn, makes materials handling an aid to their skills rather than an unpleasant handicap. This is the way Louden automatic materials handling serves the world's most modern bonded abrasives plant of the Carborundum Company that was completed recently in Logan, Ohio.

This new Carborundum plant was *designed* to gain the benefits of automation with a Louden Selectomatic Dispatch System. Materials storage is on the third floor, materials mixing is on the second floor, molding of the mixed materials is on the first floor, with interfloor transfer of materials by gravity. The Louden equipment operates in the mixing and molding departments.

Mixing operators on Louden Weighing Lorries move from spout to spout drawing grits and bonding materials from the storage above and mix these according to formulae for the grinding wheels to be manufactured. Each mix is placed in a hopper at a loading station. Then, when a press on the floor below is ready for a mix, the touch of a Louden Selectomatic control button *automatically* brings an empty carrier into position under the proper loading station, directs the carrier to the hopper of the proper press, dumps the mix, sends the carrier to an automatic cleaning station, and then returns it to the "empty" line to await another call. Six such Louden Selectomatic Carriers operate over more than 1,700 feet of Louden Monorail to serve the many presses in this molding department.

When you are planning new production facilities or the extension on modernization of your present facilities, discuss your plans or problems with Louden engineers. No company in materials handling engineering has the years of experience, the array of equipment or the record of accomplishment Louden can demonstrate. Write or wire today.

Louden

MONORAIL & CRANES

THE LOUDEN MACHINERY COMPANY
1106 Broadway, Fairfield, Iowa
A Subsidiary of Mechanical Handling Systems Inc.

SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

ASCOP

ALL MAGNETIC
SHAFT POSITION
DIGITAL ENCODERS

MODEL 506A:
13-bit natural binary output for 64 turns.
MODEL 504A:
8-bit Gray code binary, single turn.
MODEL 527A:
7-bit natural binary, one turn.
MODEL 505A:
equal increments, one turn, dual heads.

MAGNETIC, non-contacting readout in a rugged simple design assures ultra-reliable operation. ASCOP encoders are unaffected by extreme environments. Also available are new 19-bit natural binary and 100-position cyclic-binary-cyclic-decimal encoders.

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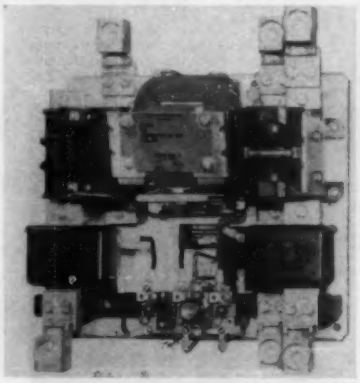
Electro-Mechanical Research, inc.
P. O. Box 3041
Sarasota, Florida

Circle 714 on Page 19

where computations are desired but the complexity of a general purpose computer is not needed. Designated as the Uni-Bloc Model 3-300 Series, these units perform on-line digital computations in any mode—addition, subtraction, multiplication, or division. They are adaptable to any type of digital system and will handle various data codes. Each unit includes its own power supply, internal programming and control, and self-checking circuitry. Unit capacities range from add-subtract (arithmetic) 10 bits in binary code, through add-subtract-multiply-divide (algebraic) 4-digits-plus-sign in 1248-binary coded decimal. **Applied Development Corp.**, 12838 Weber Way, Hawthorne, Calif.

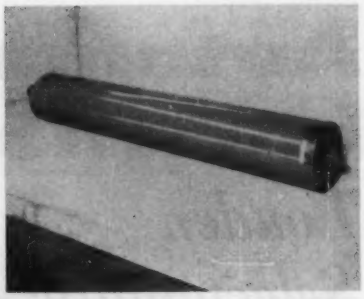
Circle 444 on Page 19



Magnetic Starter

Compact Size 5 starter is a new model in a line of magnetic starters. Maximum dimensions of the device are: Width, 13 inches; height, 15 3/16 inches; and depth, 6 1/8 inches. It can be mounted in an enclosure only 8 inches deep. Parallel double-break contacts provide four contact points to easily accommodate the heavy current surges associated with Size 5 applications. For accurate overload protection, epoxy-cast current transformers and low current overload relays are used. This starter features an internal holding circuit interlock. Four additional interlocks can be added in the field. Circuit arrangements available are normally open, normally closed, and normally closed late opening. **Cutler-Hammer**, 378 N. 12th St., Milwaukee, Wis.

Circle 445 on Page 19



Leakproof Accumulators

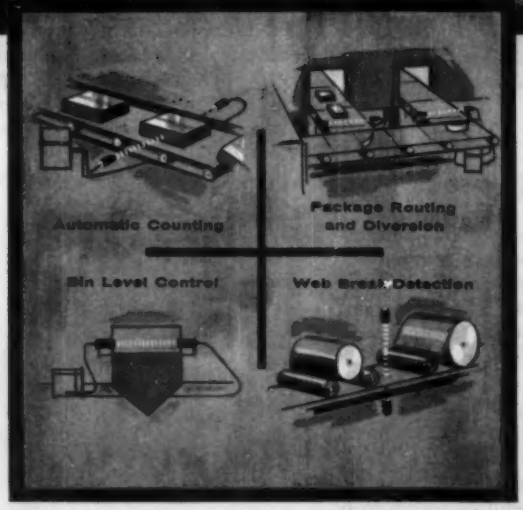
Leakproof hydraulic piston accumulators are available for use in the following industries: Automotive, automation, marine, mining, road machinery, farm machinery, foundries, machine tools, injection molding machines, hydraulic presses, power packs, chemical processing plants, and wherever fluid power is used. The free piston contains three O-rings—all of which are active in the system. An automatic check valve arrangement dispenses with pressure buildup between O-rings. The accumulator is leakproof because of this basic design and carefully maintained quality control of close tolerances. Standard operating pressure is 3000 psi covering the range of 10 cu in. to 23 gallons; temperatures −40 to +200 F. **Hydrodyne Industries Inc.**, 500 Shames Drive, Westbury, L. I., N. Y.

Circle 446 on Page 19

Motor Alternators

Series of brushless motor-alternators have no moving electrical contacts and may be combined with single or multiple rectifiers to produce brushless dc. They are available in three forms: Voltage-regulated (Asynchronous), voltage-regulated (synchronous), voltage-regulated, frequency-regulated. In the trans-

a new dimension in automated controls



SONAC ULTRASONIC,

NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration, dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assemblies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on request.

DELAVAN Manufacturing Company
WEST DES MOINES • IOWA

Circle 715 on Page 19

AIR-HYDRAULICS

NEW TABLE

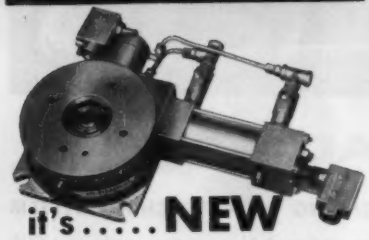
HANDLES UP TO ONE TON

Index 30 positions per minute when equipped for 6 station operation with Air-Hydraulics' new Model 2400 (24" dia.) air index table • Handles work loads up to one ton • Bolt larger diameter plates to 1¼" ground steel table top for greater table area • Repetitive shock loads are no strain • 4" bore index cylinder develops power stroke 13 times line pressure for extra power and speed—no override • Adjustable cushion and speed control • Locking cylinder, mounted on table's centerline, means positive index every time— =.0015" • Limit switch keeps basic equipment from moving until table is "locked in" • Pressure lubrication, tapered roller bearing on shaft and ample bearing surface at circumference assure friction free operation • Operates on 60 to 175 psi line pressure • 4, 6, 8 or 12 stations with clockwise rotation standard • Others, including counterclockwise rotation, and from 3 to 60 positions to order.

WRITE NOW FOR CATALOG AND PRICE INFORMATION

AIR-HYDRAULICS

LOW COST 7" INDEX TABLE



it's.....NEW

The heavy duty Model 700 is only 7" in diameter but has most of the features found on larger models • Makes up to 75 indexes per minute • Handles maximum work load of 100 lbs. • Maximum power stroke is 3 times line pressure • Operates on pressures from 60 to 175 p.s.i. • Clockwise rotation with either 4, 6, 8 or 12 stations standard • Others up to 24 stations and counter-clockwise rotation, to order • Bolt larger sub-plate (up to 14" dia.) to ground steel table for larger work area • Positive index—no override • Adjustable cushion and speed control • Each table checked for guaranteed accuracy of index (± .0015"), concentricity and parallelism.

WRITE NOW FOR FREE CATALOG AND PRICE INFO.

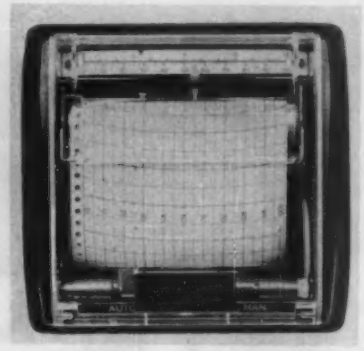
AIR-HYDRAULICS

299 HUPP AVE.
JACKSON, MICHIGAN

Circle 716 on Page 19

diode-excited synchronous alternator, designated flying-diode, as used in these combinations, brushes and collector rings are eliminated by connecting the output windings of the ac exciter through a silicon diode rectifier assembly to the dc excitation windings of the rotating-field alternator—all three being mounted on a common shaft. Standard input of the units is 220/440 volts rms ±15 per cent, 3 phase, 3-wire at 60 cps nominal. Output voltage of the two standard circuits is three phase, 120/208 volts rms nominal, 4-wire Wye; and single phase, 120 volts rms nominal, 2-wire. The units have two output frequencies, 60 cps and 400 cps nominal. They are available with five standard ratings of output power. These rotary electromechanical systems are regulated usually by static circuitry and are capable of performing in a variety of ways. **Electric Specialty Co.**, Stamford, Conn.

Circle 447 on Page 19



Control Station

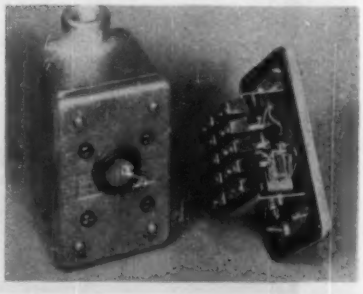
Remote control station contains all the panel-mounted components needed for pneumatic cascade control of a process. In operation, unit receives measurements from two different points in the process and records them on the same chart. Output of the primary controller pneumatically adjusts the set point of the secondary controller whose output, in turn, operates the valve. Control station requires only 6 by 6 inches of panel space. All automatic/manual switching and adjustment of set point values are made at the station. **Foxboro Co.**, Foxboro, Mass.

Circle 448 on Page 19

Turns-Counting Dial

Device combines a digital counting system with internal illumination for improved readability. Rotation is continuous for standard models, and a finger-tip brake is optional. Series 1330 direct-reading digital Microdial counts from 000 through 999 in exactly ten turns. Numbers are displayed through a sealed, one-piece lens featuring approximately 1.5 magnification for improved readability. Curved design of the lens permits wide-angle viewing. Internal illumination is offered in white light, or in red light for use in dark adapted environments. The unit is completely sealed against dust and moisture. Dark gray, light gray, red, black and white microdial caps and cantilever arms make many color combinations possible. Nonstandard colors are available on special order as are nonstandard anodized color finishes. Numerals are 3/16 inch high. **Borg Equipment Div., Amphenol-Borg Electronics Corp.**, 120 S. Main St., Janesville, Wis.

Circle 449 on Page 19



Modular Photorelay

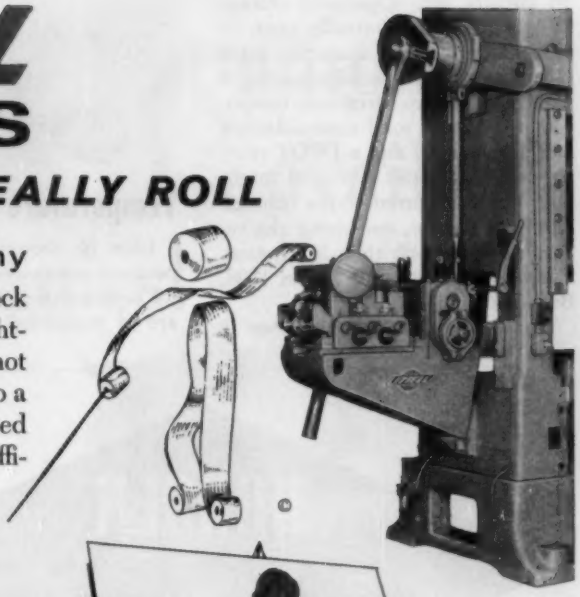
Weather resistant photorelay can be used for control, limit switch, counting, sorting, detection, go-no-

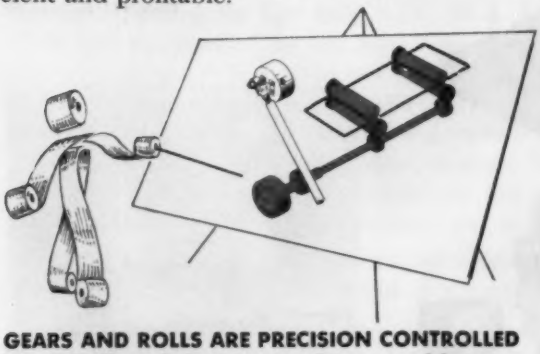
LITTELL
ROLL FEEDS

Make Press Production REALLY ROLL

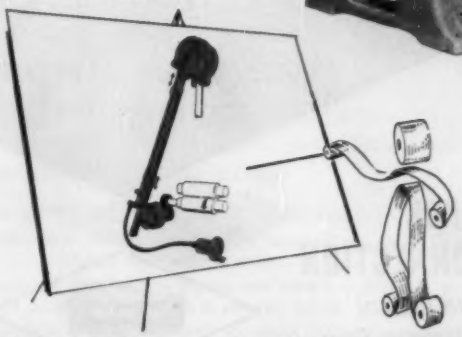
Old Pro "Coily" Points Out Why

"Coily" has been around press rooms since coil stock came into the picture. He has seen Littell Straighteners and Feeds widely copied, in design, (but not in performance) time after time. He points here to a few of the new advanced design Littell Roll Feed features that make punch press operation more efficient and profitable.

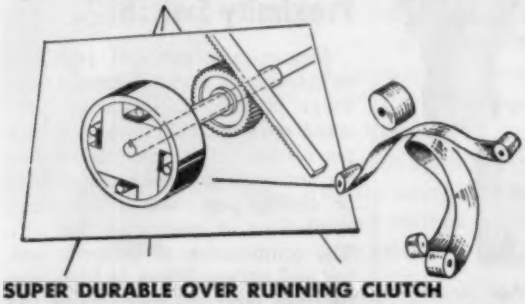




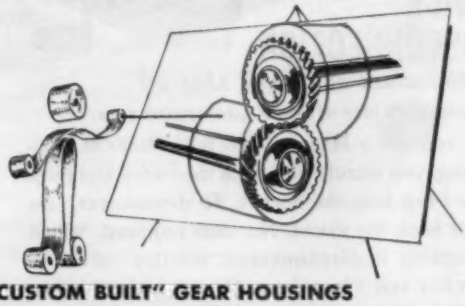
GEARS AND ROLLS ARE PRECISION CONTROLLED
Littell Rolls and Gears respond to control because they are light in weight. With less inertia to overcome, these strong, yet light rolls and gears start easy, go faster, and stop quickly. Big, new type disc brakes further assure the control that means accurate feeding in the higher speed ranges.



LITTELL MICRO RUNNING ADJUSTMENT
enables the punch press operator to adjust feed length plus or minus ⅛" while press and feed are running. A big help in setting up progressive dies requiring extremely accurate feed lengths.



SUPER DURABLE OVER RUNNING CLUTCH
Thanks to the exclusive Littell carbide cam construction that Coily points to, not a single clutch of this type has worn out in ten years of operation!



"CUSTOM BUILT" GEAR HOUSINGS
permanently hold Littell spiral gears in perfect alignment because each gear housing is specially machined for the individual spiral gears it seals in oil and protects. A Littell sustained accuracy feature.

2 New Bulletins For Punch Press Operators

Bulletin A-11
Describes Roll Feeds
For OBI Presses

Bulletin A-15
Describes Roll Feeds
For Straight Sided Presses

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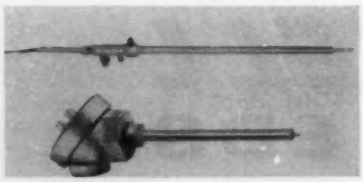
F. J. LITTELL MACHINE CO.

4105 N. Ravenswood Ave., Chicago 13
District offices: Detroit, Cleveland

ROLL FEEDS • SHEETING LINES • STRAIGHTENING AND FEEDING MACHINES • REELS AND CRADLES FOR COIL STOCK

go circuits, etc. Operating voltage is 115 volts ac. Normally open or closed contacts are available, rated 5 amperes at 115 vac. Photorelay is composed of two electronic components, a passive solid state cadmium sulfide photocell and a DPDT relay connected in series. As light intensity increases current flows through the photoresistor, energizing the relay. No warm up time is required. **Berkeley-Dynamics**, P. O. Box 1098, Burlingame, Calif.

Circle 450 on Page 19



Temperature Sensors

Line of thermocouple-type temperature sensors has been developed for temperatures up to 4000F. These are of noncooled and cooled types to measure liquid, solid, and gaseous temperatures. Some of the sensors are usable in oxidizing atmosphere up to 4000F and intermittently higher. They are available for measuring the temperatures of exhaust gas in an afterburner, molten glass, fuel pins of a nuclear reactor, combustion process, and crystal growing ovens, etc. The application range of these sensors is achieved by the use of refractory metals such as tantalum and molybdenum with special CR oxidation resistant coatings. Insulation is magnesia and beryllia. Thermocouple wires are iridium, tungsten, rhenium, and alloys of these elements. **Aero Research Instrument Co. Inc.**, 315 N. Aberdeen St., Chicago 7, Ill.

Circle 451 on Page 19

HANSEN

SERIES HK QUICK-CONNECTIVE TWO-WAY SHUT-OFF COUPLINGS

QUICK CONNECTION

with instant automatic flow

QUICK DISCONNECTION

with instant automatic shut-off

...prevents loss of liquid, gas, or pressure

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminating spilling of liquid or escape of gas at instant of disconnection.

Available in brass or steel, with female pipe thread connections from ⅛" to 1½" inclusive.

Representatives in Principal Cities
See Yellow Pages

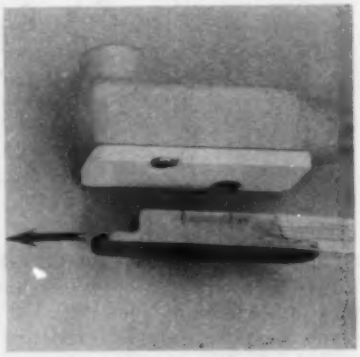
Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.

SINCE 1915 QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO



Proximity Switch

Magnetically actuated proximity switch can be used to control a wide range of circuits, including high-speed counters, actuators, and tamper alarms. The tiny magnet used for actuation may be on a rotating or sliding part and will indicate revolutions or motion of the part. The combination of hermetic sealing and encapsulation in high temperature synthetic resin makes this switch water, oil, and explosion proof. Operation sensitivity of the unit is two inches maximum; minimum response time is one millisecond. Mercury wetted contacts for currents to 5 amperes may be supplied. The switch may be mounted to a standard ½ inch electrical condulet fitting. Special specifications for mounting can be met. **Electro-Seal Corp.**, 946-A North Ave., Des Plaines, Ill.

Circle 452 on Page 19

America's finest automatic transfer machines now available to outside companies!

You know Sylvania for light bulbs, radio tubes, fine electronics equipment. (You also know how exacting specifications have to be to make such fine products on automation machinery.) Over 20 years ago Sylvania discovered there were no transfer machines available to meet our unusual standards of required accuracy. To get the exceptional machines we needed, we had to make them ourselves. We have been doing it ever since.

Now these machines are available to outside companies seeking this same extraordinary degree of accuracy.

Ideal for high-speed automatic fabricating, finishing, assembling, indexing, packaging, these machines are available in two general types:

1. Rotary indexing chassis in two sizes and in single and double turret models. Made with unusually great driving and tool capacity. Note: top of transmission spider is specially machined for rotary vacuum or pressure valve.

2. Conveyor indexing chassis, exceptional for the extreme accuracy, strength and versatility of its chain—not made commercially, but by Sylvania itself. You also get greater tool and driving capacity than in other such chassis on the market.

Also, precision indexing transmissions (5 models)

- **Heavy-duty unit** with extra-large cam well and spider diameter for wider range of stops per revolution.
- **Standard unit** features higher cam speeds, a provision to integrally mount rotary vacuum or pressure valves.
- **Universal unit** operates with its output shaft horizontal or vertical. Has wide range of applications.
- **Small universal unit.** Lower silhouette and extra-long input shaft are main features of this extremely durable, accurate transmission.
- **Conveyor unit.** Very rugged, heavy-duty unit designed for conveyors, but easily adaptable for rotary tables, other intermittent motion machines.

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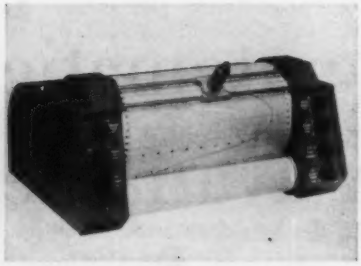
SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



Incremental Recorder

High-speed, precision plotting of computer processed data is made possible with this incremental recorder. The device converts digital information regarding the relative variation of two functions into corresponding incremental motions of the plotting paper and the plotting pen. This graphical representation of the relationship between the two functions is accurate to within one-hundredth of an inch, the size of the basic plotting increment. Model 560-RX-Y digital incremental plotter can accept data from all digital computers and can be driven by both punched paper tape and punched card data processors. These capabilities give the plotter excellent on-line and off-line potential in such applications as monitoring industrial processes, evaluation of processed flight test data, statistical surveys, and analysis of time varying systems by digital differential analyzers. The instrument can provide up to 200 incremental steps per second on each axis and Z-axis modulation can be maintained at up to 10 operations per second. The recorder is completely transistorized and utilizes a self-contained power supply. **California Computer Products Inc.**, 8714 Cleta St., Downey, Calif.

Circle 453 on Page 19

Color Coder

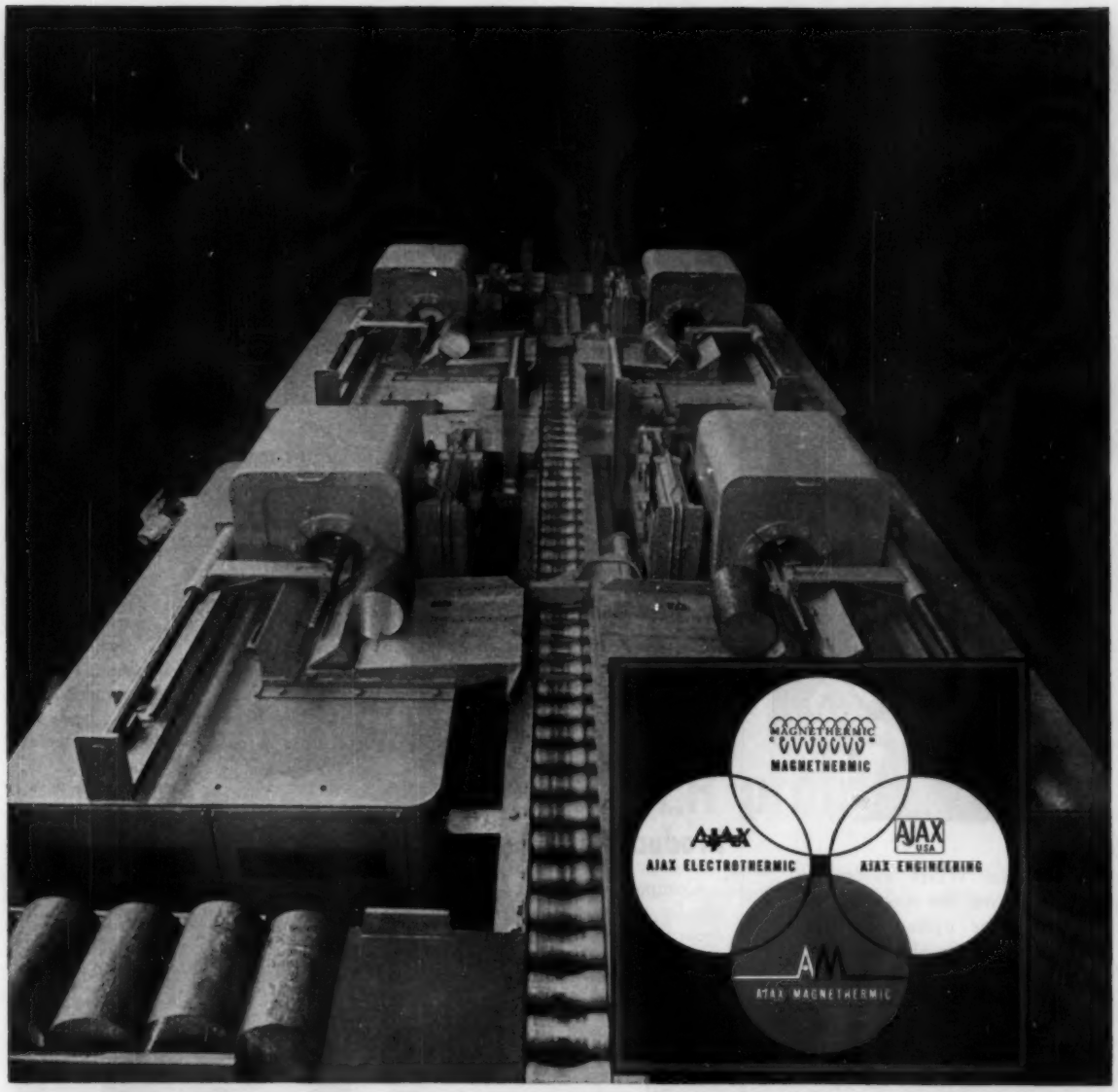
Machine is suitable for production coding, marking, and printing in three colors at one time. It prints a legend three inches high and up to 15 inches long and uses porous plastic rollers to retain its ink supply. By varying these plastic rollers, packagers and shippers may have simultaneous three-color printing. Model 603 Teko coder can be used to print from virtually any position —including overhead—on any level surface of filled bags, packages, cartons, shipping containers, or other porous materials. Simple locking devices, which hold both the plastic cylinders and the printing head in place, allow for quick, easy changeover. Ink fountains, reservoirs, and transfer rollers are not required. The plastic cylinders for the coder are available in violet, red, or black, with other colors available on special order. They hold enough ink in suspension for the printing of up to 150,000 legends. **Thomas Engineering Co.**, 9257 N. Laramie Ave., Skokie, Ill.

Circle 454 on Page 19

POST
ELECTRONIC
PRODUCTS
Model K-1A — When the light beam is not interrupted — output relay is energized.
Model K-1B — When the light beam is interrrupted — output relay is energized.
Model K-2 — Photoelectric timer with adjustable (.05-10 sec.) output relay closure.
Model K-3 — Photoelectric stop-motion and jam detector:
K-3R — When light beam is interrupted for the present time delay-output relay is energized.
K-3F — When light beam interruptions cease for a preset time delay-output relay is energized.
Decitron
POST ELECTRONIC PRODUCTS
Division of Reid Brothers Company, Inc.
12 LOTHROP ST. / BEVERLY, MASS.

Expendable Thermocouple

Device has been developed for measuring steel bath temperatures. Designated the Temtip cartridge, this thermocouple and its receptacle are fully compensated to assure accuracy. The male terminal post is located on the cartridge, rather than on the receptacle. Electrical connections between cartridge and receptacle are assured by a sliding pressure contact. The terminal post is constructed of wood to minimize heat conduction. A tight-gripping metal cap on the cartridge protects the sensitive platinum thermocouple



At Scovill Manufacturing Company, Waterbury, Connecticut, these four Ajax Magnethermic Induction Heaters heat 9" x 16" copper and brass billets for a 2500 ton extrusion press at the rate of 60 billets per hour. Each heater is rated 450 KW. The four heaters in tandem are served by a common loading and unloading conveyor.

THE NEW NAME WITH THE FAMILIAR RING!

60-Cycle Induction Billet Heaters manufactured by AM, one of our many products for induction heating or melting of all types of metals.

"induction heating is our only business"

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Youngstown 1, Ohio

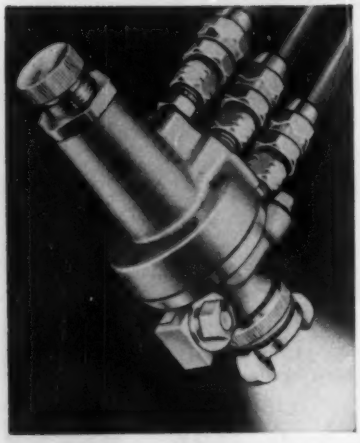
TRENTON DIVISION
930 Lower Ferry Road
Trenton 5, New Jersey

YOUNGSTOWN DIVISION
3990 Simon Road
Youngstown 1, Ohio

Circle 721 on Page 19

DeVilbiss spray guns apply almost anything that pours — automatically!

Spray lubrication



DeVilbiss WDB automatic spray guns are specially designed for cycled or continuous application of lubricating oils and drawing compounds during metal forming operations. Guns are adjustable for spray-pattern size, shape, and fluid volume. Apply measured amount of materials exactly where needed. Instant-acting pneumatic control provides up to 90 spray cycles per minute. Call our nearest representative. The DeVilbiss Company, Toledo 1, Ohio. Branch offices in principal cities.

FOR TOTAL SERVICE, CALL
DEVILBISS

Circle 722 on Page 19

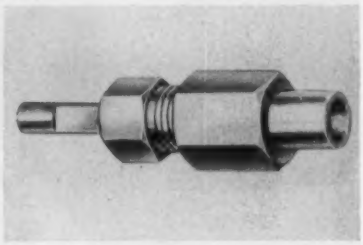
from slag or floating solids during immersion. The cartridge utilizes a Speedomax temperature recorder. When the operator connects an expendable thermocouple, the Speedomax recorder lights a green signal to indicate that the circuit is complete and ready for a reading. As the immersion is made, an amber light shows the recorder is responding normally; and after only five seconds, a red light and an audible signal inform the operator that the measurement is complete. **Leeds & Northrup Co.**, 4934 Stenton Ave., Philadelphia 44, Pa.

Circle 455 on Page 19

Product Recorder

Compact product recorder is ideally suited for watt or kilowatt recording and for multiple measurements such as weight x speed and flow x density. Model 6717 houses two independent measuring systems within a single case. Employing two electronic amplifiers, the instrument operates on a null balance principle. Two independent millivolt signals are connected to the individual inputs. The signals are multiplied and the product is recorded. Multiplying is accomplished through use of a retransmitting slidewire on one measuring circuit wired to the input of the second measuring circuit. The range of the two completely separate measuring circuits can be rapidly changed. Standard carriage speed across full scale is 2 seconds. Chart speeds provide a range of 1 inch per hour to ½ inch per minute and the speeds can be changed quickly. Higher speeds are available with a special motor. Alarm switches are available for each measuring circuit. Each circuit has provision for the addition of six separate back set, individually adjusted switches. **Weston Instruments Div., Daystrom Inc.**, 614 Frelinghuysen Ave., Newark 12, N. J.

Circle 456 on Page 19



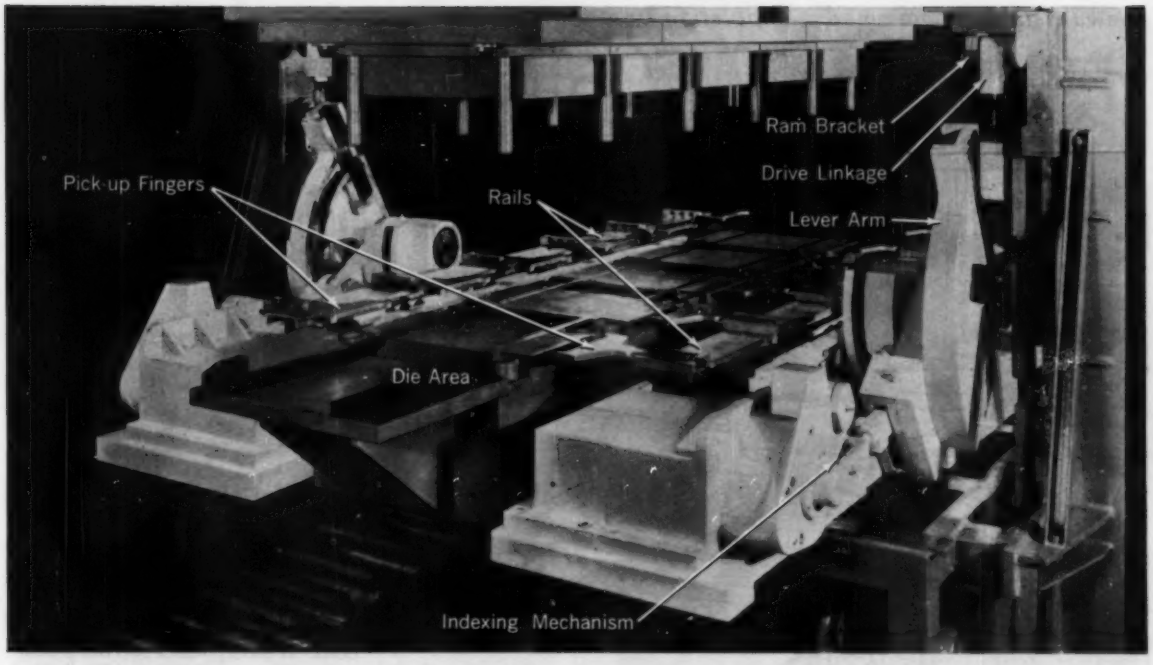
Vacuum Couplings

Line of ultra-high vacuum couplings is available in sizes for ⅛ inch through ⅝-inch OD tube. When using these couplings, no leaks are detectable or measurable on a helium mass spectrometer with a sensitivity of 1.7 by 10^{-10} atmospheres cc/sec/division. Their all metallic design permits operation at elevated temperatures. **Cajon Machine Co.**, 902 E. 140 St., Cleveland 10, Ohio.

Circle 457 on Page 19

Reducing and Relief Valve

Unit has been designed for initial pressures of 4000 psi with water, oil, air, or gas. Model 3851 Type F valve is available in ½ and ¾ inch sizes. It is used to supply a process or piece of equipment requiring small capacity or a small unit under test and controls pressures within as little as 2-3 lbs per square inch over the entire adjustable range. This single-seated, spring-loaded, diaphragm actuated



Automate your presses... for BIGGER profits!

Increase your production, improve the quality of your products and get your manufacturing costs down—with your present equipment.

This happy position is being enjoyed now by users of Sheffield PRESS-PACERS—demountable transfer devices which automate any straight side press or line of presses. Parts can be transferred from die to die in one press, or between presses in lines up to more than 125 feet long.

One press can be made to do the work of as many as five or six presses, reducing equipment and space requirements. The number of transfer operations is limited only by the capacity of the press or line of presses involved. Automatic handling from press to press prevents scrap generated by manual handling.

PRESS-PACERS are completely flexible. They have been tooled to handle interchangeably as many as seven parts. Model or engineering changes do not obsolete a PRESS-PACER—they only increase its value.

Blanks, pre-drawn parts, sheet and coil stock may be used, as desired. Feed fingers are interchangeable—feed distance is adjustable.

Sheffield provides complete single-source responsibility in PRESS-PACER production including (1) design and build tooling, (2) building of standard PRESS-PACER, (3) provision for minimum scrap and scrap removal, and (4) installation in your plant, warranted to perform to specifications and your satisfaction.

You can see eight different PRESS-PACER installations right in your plant by means of a sound movie in color—and discuss your opportunity for savings with a factory engineer . . . write, wire or phone Contract Manufacturing Division.

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A subsidiary of The Bendix Corporation

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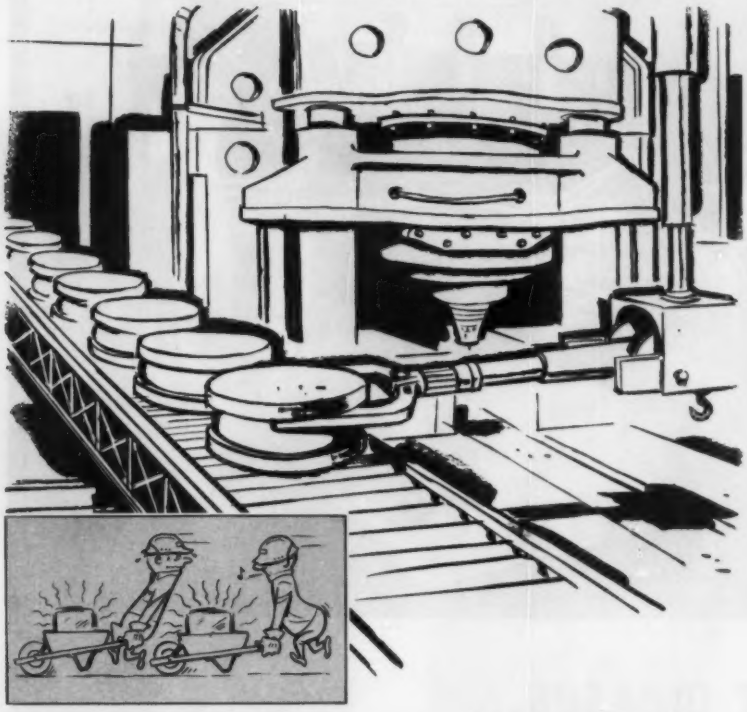
New twists in programmed manipulation from General Mills



STOP BEEFS! This Mechanical Arm may solve your handling problem

Many of industry's awkward handling problems are *still* being solved with relatively primitive manual techniques. You've heard the beefs! Moving heavy, bulky materials . . . hazardous environmental conditions . . . precise coordination—these are tough requisites for any materials-handling system.

Here's a way to free production workers of the drudgery, boredom and danger inherent in many industrial tasks . . . and save money too! General Mills electro-mechanical manipulators were developed for atomic installations requiring delicate handling in untenable radioactive areas. Our technical know-how and engineering experience suggest a number of industrial possibilities for solving your tough handling problem.

Coupled with a General Mills analog controller, the versatile Mechanical Arm can automatically play back extremely complex wrist-arm sequences . . . tirelessly, perpetually and without human error. Low cost recording medium permits automation of short run repetitive operations . . . with instruction changes made in minutes.

For more facts on programmed manipulation, write for our booklet *Automatic Handling:* General Mills, Nuclear Equipment Dept., 419 North Fifth Street, Minneapolis 1, Minnesota.

NUCLEAR EQUIPMENT DEPARTMENT

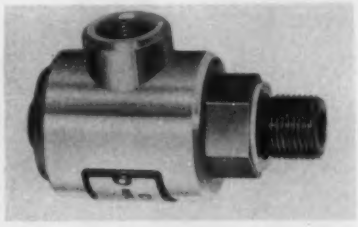
General Mills **MECHANICAL ARMS**

First in Remote Handling

Circle 724 on Page 19

valve has adjustable pressure ranges of 0-1000, 0-2000, and 0-3500 psi. Features include molded neoprene diaphragm with nylon insertion, push rod for external adjustment of relief feature, and handwheel for easy adjustment of reduced pressures. **Atlas Valve Co.**, 280 South St., Newark 5, N. J.

Circle 458 on Page 19



Rotating Union

Slow-speed hydraulic union is designed for single passage applications. It incorporates two oilite bearings to eliminate any radial load which may be applied to internal O-ring seals. With the hose entrance between the O-rings, any thrust due to line pressures is balanced. Model 15 is ideally suited for installations where the shaft speed is not over 250 rpm. Suitable for 150 psi air pressures or 2000 psi hydraulic oil pressure, this union is available for ¼-inch psi hose connections. Double passage unions are also available. **Deublin Co.**, 1919 Stanley St., Northbrook, Ill.

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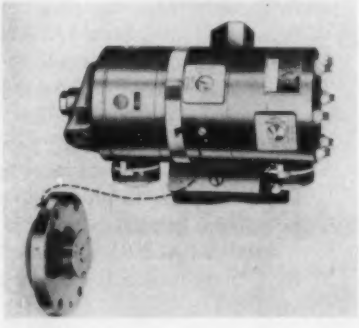


Pneumatic Controllers

Devices employ metal bellows in the unbalance detector and are recommended for batch-type processes with frequent startups, and for installations where ambient temperature is variable. Series 650 pneu-

THE GENTLE MEANS OF CONTROL FOR STOP-AND-GO MACHINES!

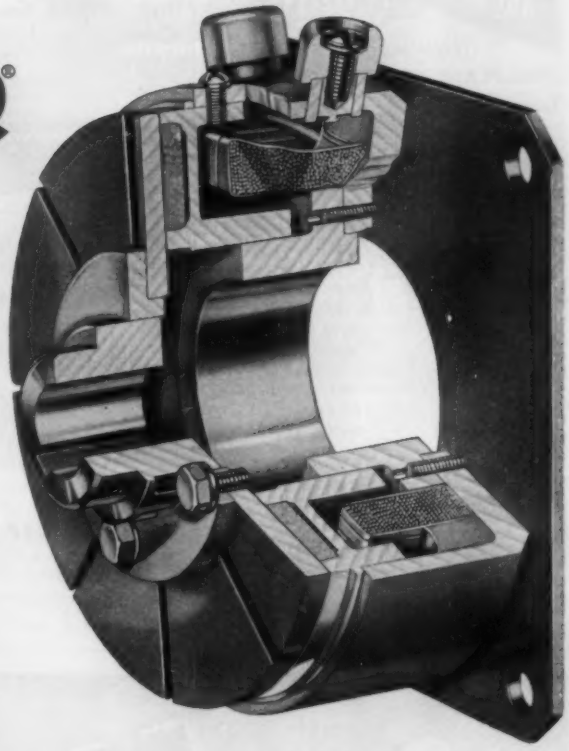
EATON DYNA-TORQ® Magnetic-Friction Clutches and Brakes

Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, shock-free method of controlling power and motion in today's complex production and processing machines—or for equipment you may now have in the design stage.

Dyna-torQ units utilize the simple principle of electro-magnetic engagement of two friction members (field-magnet and armature) to transmit driving or braking torque.

Extremely rapid response without backlash or chatter makes Dyna-torQ units ideally suited to a wide range of automatic cycling applications.

Carefully selected and tested materials, high quality of workmanship, and important design features provide long operating life, minimum down-time, and low maintenance cost.



Dyna-torQ units are offered in a diversified line including clutches, brakes, clutch-brakes, and clutch couplings. Sizes range from 1½" to 15" in diameter. They are easily and quickly installed on new machines or existing plant equipment.

INSTANT RESPONSE: Short armature travel—1/32"—and the direct pull of the magnetic field on the armature eliminate any need for mechanical linkage; prevent backlash and lost motion.

INSTANT RELEASE: Dyna-torQ design permits instant release of armature when field coil is de-energized; there is no residual flux to delay action.

HIGHLY EFFECTIVE COOLING: Fanning action of armature carries heat away from unit; reduces operating temperature.

NO ADJUSTMENT: Proper clearance between the armature and field magnet is maintained automatically.

SIMPLE, ACCURATE CONTROL: Closely held rate of acceleration and deceleration prevents shock to gear trains and other linkage. Small, compact Dyna-torQ controls rectify alternating current to furnish direct current for the coil of the field magnet assembly.

INTERCHANGEABLE PARTS: Corresponding parts of all Dyna-torQ units of a given capacity are interchangeable.

Send for Illustrated Literature Covering the Complete Dyna-torQ Line

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ORIGINATORS OF EDDY-CURRENT SPEED CONTROL EQUIPMENT

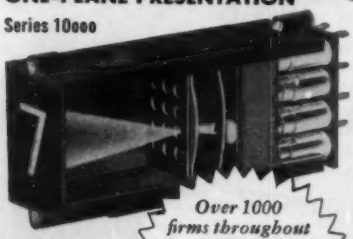
ALL DIGITS CAN BE READ FROM ANY ANGLE

IN-LINE DIGITAL READOUT

featuring

ONE-PLANE PRESENTATION

Series 10000



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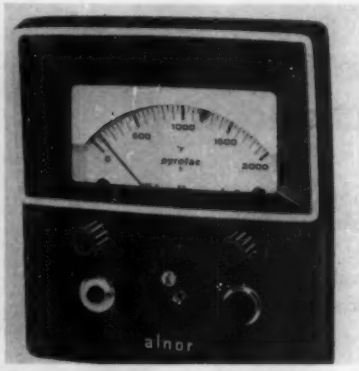
North Hollywood, Calif.

Circle 726 on Page 19

matic controllers containing bellows are offered with integral or remote set-point for the following control modes: On-off, adjustable proportional, proportional plus reset, fixed proportional plus reset, and proportional plus reset plus derivative control. **Bristol Co.**, Waterbury 20, Conn.

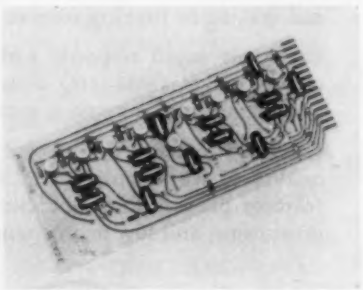
Circle 460 on Page 19



Temperature Cutout

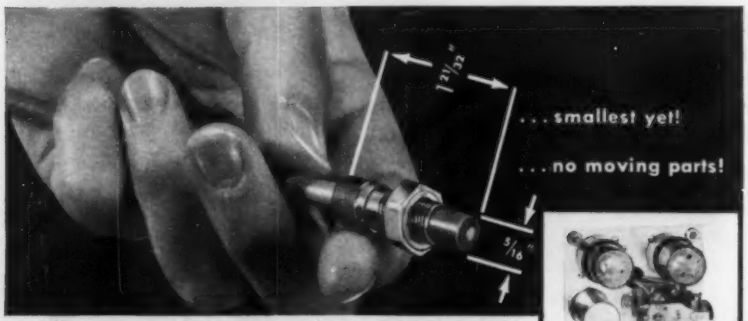
This electric instrument combines automatic protection against excess temperature with continuous temperature indication. It is available in two models: Model N-30 which will not shut off upon line voltage failure and Model N-34 which will shut off in such a condition. Designated Pyrotac, the instrument can be used also to sound an alarm and/or light a signal upon excess temperature condition. It can be supplied as a low temperature cutout when so specified. Though primarily intended for use in conjunction with other controllers, it can also serve as the only control instrument for a process requiring complete shutdown upon reaching a final preset temperature, or when operator attention is required upon completion of a temperature cycle. The excess temperature controller is available in eleven ranges from 0-400F to 0-3000F, as well as an environmental test chamber range of −100 to −300F. **Alnor Instrument Co., Div., Illinois Testing Laboratories Inc.**, 418 N. LaSalle St., Chicago 10, Ill.

Circle 461 on Page 19



Decade Counter

Transistorized binary decade counter has been developed for general purpose applications in data acquisition, data processing, and digital control. It is designed to count in the 1-2-4-8 mode and provides compatibility with the widely used IBM data coding. Complementary outputs in the form of direct collector connections enable up to three ma loading for many external logical manipulations. Designed to operate from 0 to 100 kc, the counter supply voltage may be varied by over a 2 to 1 margin. This feature permits application of Model 11G to exiting power sources in the range from ±7.5 to ±17 volts. By deletion of flip-flop coupling component, the counter may be easily converted to a 4-bit register and achieves a pack-



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Proximity Switch

OBTAINABLE!

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Now Electro offers you a low cost proximity switch incorporating the basic *patented* circuit used successfully in industrial plants for more than 5 years.

$86.00

users net includes:

Control amplifier 4902
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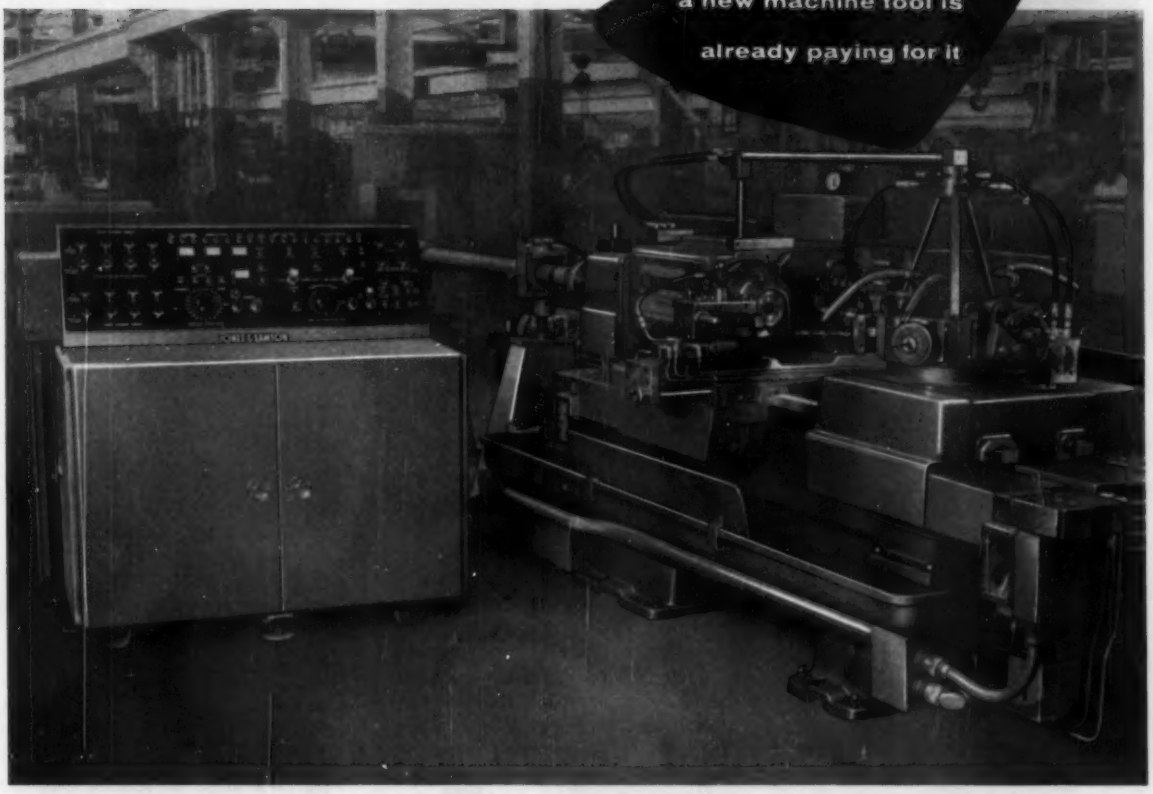
Most complete line of Proximity Switches and Magnetic Transducers · Tachometers · DC Power Supplies

JONES & LAMSON "AUTOMATION"

the man who needs a new machine tool is already paying for it



New numerically-controlled turret lathe shatters idle time . . . is ideal for short runs

At the last Machine Tool Exposition, five years ago, Jones & Lamson exhibited an automatic tape-controlled turret lathe. It created a sensation and attracted thousands of fascinated spectators. Many of them wanted to buy. But the machine wasn't for sale. Why? Because there were still "bugs" in it to be ironed out, and our reputation is too valuable to risk on an "almost" product.

In the five years since, J & L still kept this lathe off the market, pending its complete development and proving-out. Now, it is ready to be shown, ready to be sold, ready to help you attain new production efficiency.

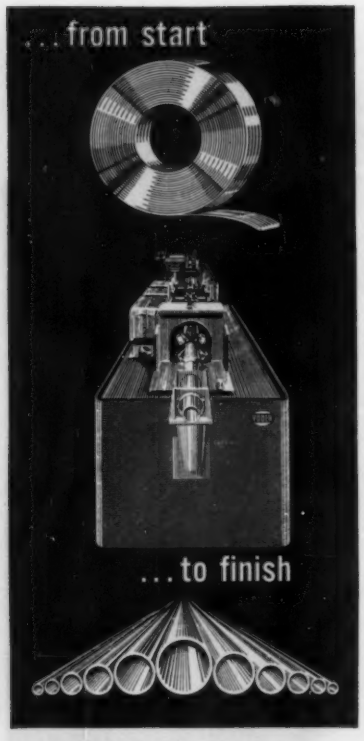
The new J & L numerically-controlled turret lathe is a complete redesign job. The sound features of the early prototype have been retained, and all question marks have been eliminated. In every way, this is a real beauty!

It's designed especially for short run production and top economy. It has the capacity of a No. 5 machine, 2½ x 24 in., and has three turrets (one hexagon and two square) which accept up to 14 preset tools. A set of tools plus the tape can be "packaged", ready for set-up when needed.

This lathe can be set up as either a bar machine or a chucker, in 10 to 15 min. It positions within .001″, repeats to .0005″. Drive motor is 30 HP, with spindle speeds of 40 to 2000 rpm in 24 steps. Feed rates for carriage and saddle are .750″ to 30.0″ per minute in 16 steps, plus fast motion. Cross-slide operates at one-half these rates. Tape input information may be adjusted for extended tool life and size control by manual dials on the control panel. Productivity is increased 25 to 30% over standard cycle time. Even the automatic bar feed is programmed from the tape. See it at Chicago, or write for advance information now. Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 728 on Page 19



YODER PIPE & TUBE MILLS

A Yoder engineer can help you realize remarkable savings in the manufacture of ferrous or non-ferrous pipe or tube. He can show you how present Yoder Pipe or Tube Mill owners are increasing production, lowering over-all manufacturing costs and reducing downtime through use of Yoder Mills.

If your products require pipe or tubing from 3/16" to 26" diameters, Yoder Pipe or Tube Mills and accessory equipment can help you produce your product more efficiently to meet today's competitive markets.

In addition to Pipe or Tube Mills, Yoder engineers and builds a complete line of Slitting equipment and Cold Roll-Forming Machinery.

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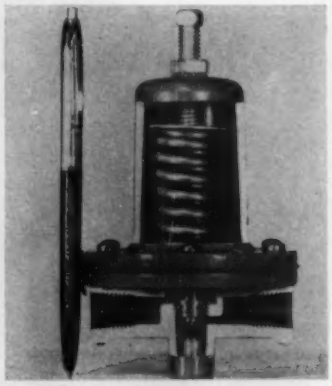
THE YODER COMPANY
5526 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING — PIPE AND TUBE MILLS (ferrous or non-ferrous)

Circle 729 on Page 19

ing density of over 100 flip-flops in the 3½-inch panel space of a 19-inch rack. **Electronic Counters Inc.**, 155 Eileen Way, Syosset, L. I., N. Y.

Circle 462 on Page 19



Instrument Regulator

Device is suitable for air supply lines for production equipment such as presses, pneumatic tools, and paint sprays, or wherever a controlled supply of air or gas pressure is needed. Applications include controlling inlet pressures on sensitive controlling, regulating, and recording devices. Model 080 has a maximum inlet pressure of 250 psi and outlet pressure ranges of 0-5, 5-35, and 35-100 psi. Optional attachments include a handwheel adjustment and a ¼-inch side outlet tap for pressure gage mounting. **Rockwell Manufacturing Co.**, 400 N. Lexington Ave., Pittsburgh 8, Pa.

Circle 463 on Page 19

Die Protection Device

Electrically controlled die protection device, designated the Di-Matic, disengages a press clutch instantly should material misfeed, buckle, pile up, or come to an end. Various

For on-the-line package weight control — W-C CHECK-WEIGHING SYSTEMS

Whatever your requirements for production check-weighing of packaged materials, W-C can supply a job-engineered system to meet them. Systems can be automatic or manual; can weigh in motion or stop-and-go; can segregate packages according to specific zones of under- or overweight, or according to a single pre-selected tolerance. They can provide practically any type of readout you want, and can be readily integrated with tape-fed, punched-card and other types of data handling systems.

Surprisingly, such job-engineered systems can be delivered at a most realistic cost—probably less than you'd expect. The reason why is a simple one: pre-engineered components, unitized design. There is no speculation or experimentation; W-C systems are designed on the very practical basis of service-proven, standardized components.

Typical applications include: Checking weight of tire treads as extruded . . . checking container weights after automatic filling . . . checking multi-unit package weights.

Write for new Bulletin 60

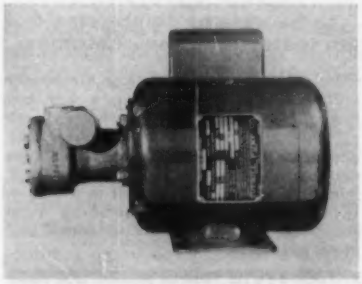
W-C **WEIGHING & CONTROLS, INC.**
Div. of CompuDyne Corp.

E. County Line Road • Hatboro 12, Pa.

Circle 730 on Page 19

models make the unit suitable for air (friction) as well as mechanical (key) type clutches. Accessories include stock thickness detectors that stop the press before extra-thick metal enters the die; remote control outlets timed with the run-stop motion of the press; misfeed pilots and bushings; lifetime contact switches; and clutch conversion kits. Other units check for parts that fail to eject in progressive dies and missing parts in transfer units. **Diecraft Tool Co., Inc.**, 100 Beadel St., Brooklyn 22, N. Y.

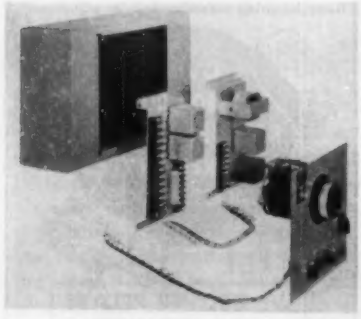
Circle 464 on Page 19



Pump and Motor Unit

Designed for use in hydraulic, lubrication, oil burning, and fuel transfer services, this pump and motor combination includes motors in the NEMA 56 series ranging from ¼ to 1 hp in either single or three phase. These motors may be combined with a selection of five different pumps with capacities from 20 to 360 gph. **Tuthill Pump Co.**, 939 E. 95th St., Chicago, Ill.

Circle 465 on Page 19

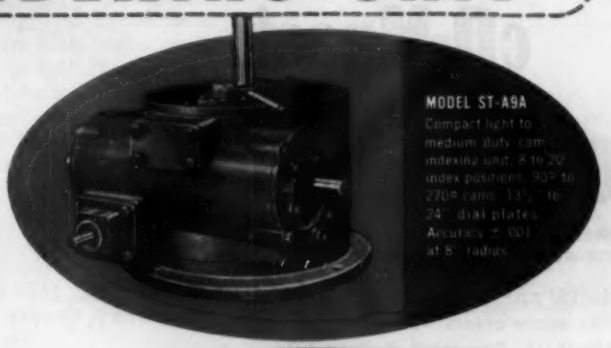


Adjustable Speed Drives

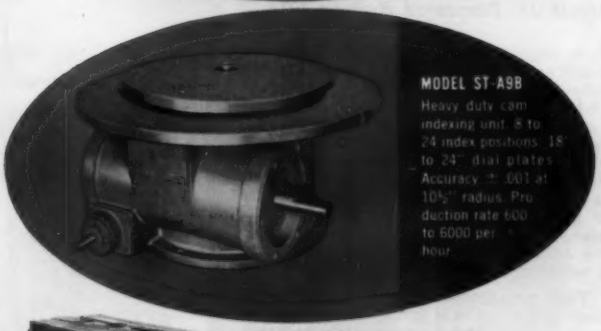
DC motor drives employ adjustable autotransformers in combination with full wave rectifiers to at-

You can
PRODUCE & ASSEMBLE *Automatically*
when your machine is designed around a Standard Tool
INDEXING UNIT

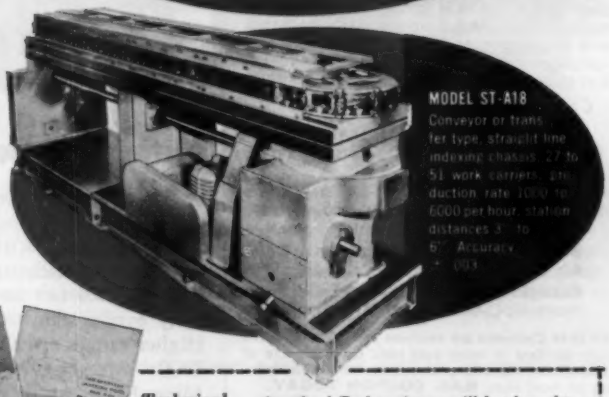
The Heart of Automatic Machines



MODEL ST-A9A
Compact light to medium duty cam indexing unit. 8 to 20 index positions. 90° to 270° cams. 13" to 24" dial plates. Accuracy ± .001 at 8" radius.



MODEL ST-A9B
Heavy duty cam indexing unit. 8 to 24 index positions. 18" to 24" dial plates. Accuracy ± .001 at 10½" radius. Production rate 600 to 6000 per hour.



MODEL ST-A18
Conveyor or transfer type, straight line indexing chassis. 27 to 51 work carriers, production rate 1000 to 6000 per hour, station distances 3" to 6". Accuracy ± .003

Technical Booklets Sent on Request!

Standard Tool engineers will be pleased to help you in selecting the indexing unit to meet your exact requirements.
Also ask for Standard Tool facilities brochure.

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Machines for Shaping America's Future
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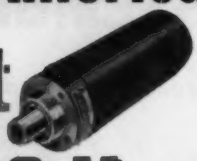
STANDARD TOOL AUTOMATION
Since 1910

Circle 731 on Page 19

America's First cO-Mpact Cylinder



INTERNAL KEY
TIE-RODLESS-TYPE SERIES 101A

Air 150 psi—Hydraulic up to 1500 psi
Fits where others won't
Meets JIC Standards, Bulletin 101A

This original space-saving cylinder is the most compact, streamlined and versatile cylinder available. It requires one-third less installation space and has a greater ratio of power to its size and weight than tie-rod-type cylinders with the same bore and psi rating. In addition, the ports can be rotated independently to any convenient location. It is easier to service. And by using a majority of standard parts and one or two semi-standard parts, this component gives you the advantage of special cylinders that do a better job at a nominal cost.

This compact unit has the lowest coefficient of friction. It is designed right to seal right . . . to make full-power starts on thrust and return strokes . . . to maintain perfect rod alignment . . . and cushion piston shocks. End plugs are tapped for universal mounting.

Coupon below brings Bulletin desired.

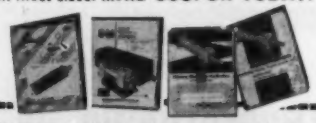
Bulletin 101A for Internal Key Tie-Rodless type Air and Hydraulic Cylinders featured above.

Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders Hydraulic 2000 psi; 3000 psi non-shock.

Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.

Bulletin 108—Automation (Heavy Duty) Hydraulic Cylinder—for 1000 psi operation.

All O-M Cylinders are available in 1½" to 8" bores with standard or heavy-duty rods. Complete line of mounts and interchangeable parts. Immediate delivery on most sizes. **MAIL COUPON TODAY.**



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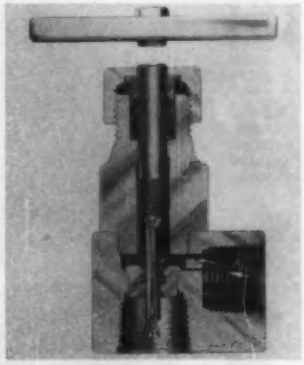
Circle 732 on Page 19

tain infinitely variable speed adjustments over a wide range. They are applicable to a variety of industrial drive problems such as those encountered in conveyors, winding machines, agitators, and other production machinery. Series 35 electrical adjustable speed drives are available in Size 1 for 1/3 hp, maximum, and Size 2 for ¾ hp, maximum. Two other sizes are offered, with maximum ratings up to 10 hp. Illustration shows modular construction of Size 1 which permits prewiring and prestocking of a wide variety of chassis to meet different specifications. Component parts are: Enclosure, relay panel, rectifier panel, control panel, and cables for interpanel wiring. **Cleveland Machine Controls Inc.**, 1155 Brookpark Rd., Cleveland 9, Ohio.

Circle 466 on Page 19



Metering Valve

Unit has been designed for the control of ultra-small amounts of liquid or gas. With this valve a Cv (flow coefficient) of as low as 0.003 to zero can be controlled linearly over a stem travel of ⅝ inch. Higher ranges are also standard. At 5000 psi the valve, designated Micro-Flow, can be throttled from 3 ccpm to 5 gpm. At lower pressures the valve has been used to deliver as little as 10 drops per hour. Pressure ratings are to 10,000 psi. Clog and vibration resistance are obtained by restricting all flow to a variable triangle - shaped orifice. Standard construction materials are carbon steel, stainless steel, or bronze. Air diaphragm actuated valves which respond to a 3-15 psi signal are available. **General-American Valve Co.**, P. O. Box 444, Corona Del Mar, Calif.

Circle 467 on Page 19

If your product is . . .

TOO BIG
for use by a salesman or in a trade show.

TOO HEAVY
for a salesman to carry.

TOO EXPENSIVE
to give to your salesman and representatives.

TOO SMALL
to be able to demonstrate its features to the customer.

Used as a selling tool, a scale model will solve all these problems • A model can be constructed to show the features of your product where very often the actual article is not suitable • A picture is worth a thousand words • A model is worth a thousand pictures • Write for brochure describing how scale models can open doors and sell your product.

"VISUAL" Plant Layouts, Inc.
99 Pennsylvania Ave.,
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Circle 733 on Page 19

SAVE TIME and EXPENSE on PURCHASING RELAYS

IMMEDIATE DELIVERY
Off Shelf Items
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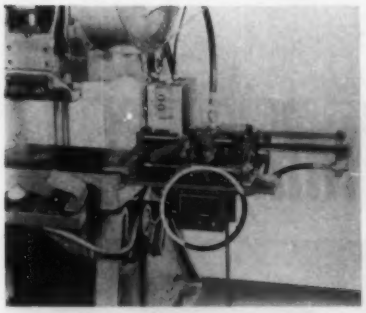
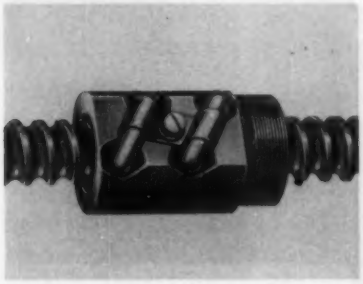
Circle 734 on Page 19



Sequence Counter

Device makes possible longer feed lengths on air operated slide feeds. In operation, the sequence counter allows the air feed to advance the stock from one to seven times before the press is tripped. The 24-inch air feed, shown, can automatically feed stock from 1 to 168 inches in length before the press is actuated. The sequence counter can be wired directly into an air clutch control panel or can, with the addition of an air cylinder, operate a mechanical clutch press. **Cooper-Weymouth Inc.**, 600 Honeyspot Rd., Stratford, Conn.

Circle 468 on Page 19



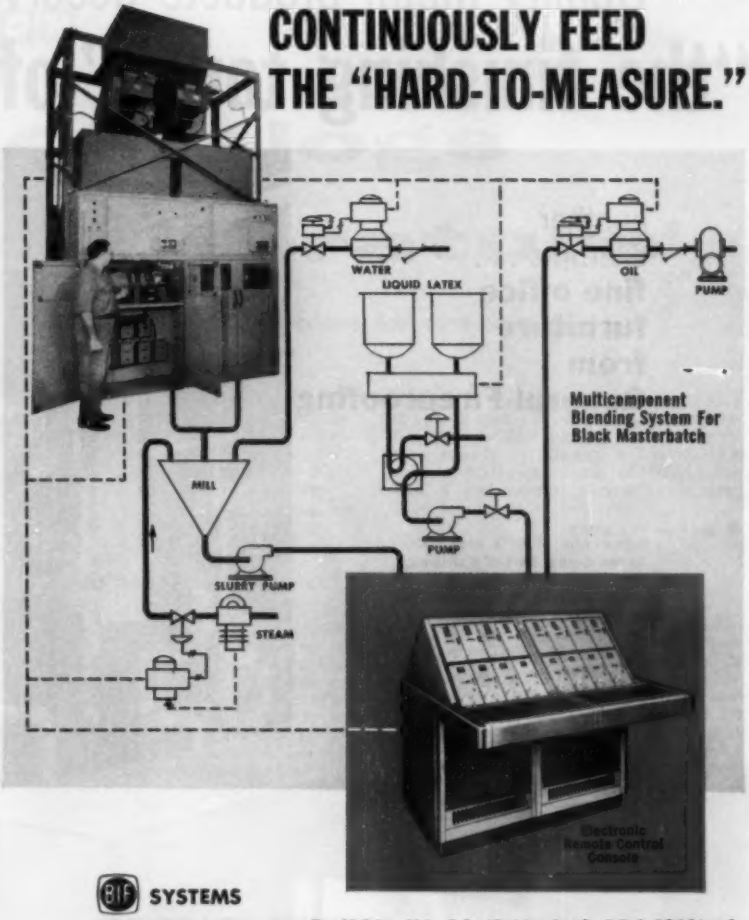
Ball Screws and Splines

Line of standard ball screw and ball spline assemblies are available in a range of sizes. Their applications lie principally in the moving of loads with low break-away friction, minimum space requirements, and low service requirements resulting from minimized friction and wear. These assemblies have an efficiency of about 90 per cent and are designed for service where extreme precision of ground thread, preloaded types are not required. **Beaver Precision Products Inc.**, Clawson, Mich.

Circle 469 on Page 19

POSITIVE CONTROL OF *MATERIALS IN MOTION* BIF METERS FEEDERS CONTROLS

CONTINUOUSLY FEED THE "HARD-TO-MEASURE."



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For difficult processing problems involving hard-to-handle, hazardous or toxic materials, B-I-F offers "systems know-how" combined with 25 years field experience in feeding techniques.

B-I-F performance-proved, loss-in-weight feeding systems are currently being used for such difficult materials as: Carbon Black, Latex, Ammonium Perchlorate, Tetraethyl Lead, Catalysts, Food Additives and High Vapor Pressure Liquids.

Here's why:

- Materials are completely enclosed in feeding unit which can be pressurized with inert gas.
- Feeds any flowable solid or liquid material from 1 to 60,000 pounds per hour. Built-in rangeability to meet specification from 10 to 1 to 50 to 1 depending on material.
- Accuracy — ¼ of 1% by weight of set feed rate. Automatic feedback control loop prevents cumulative error.
- Proportional pacing by mechanical, electrical, pneumatic or electronic controls.
- Rate of feed may be controlled locally or remotely.
- No field calibration required.

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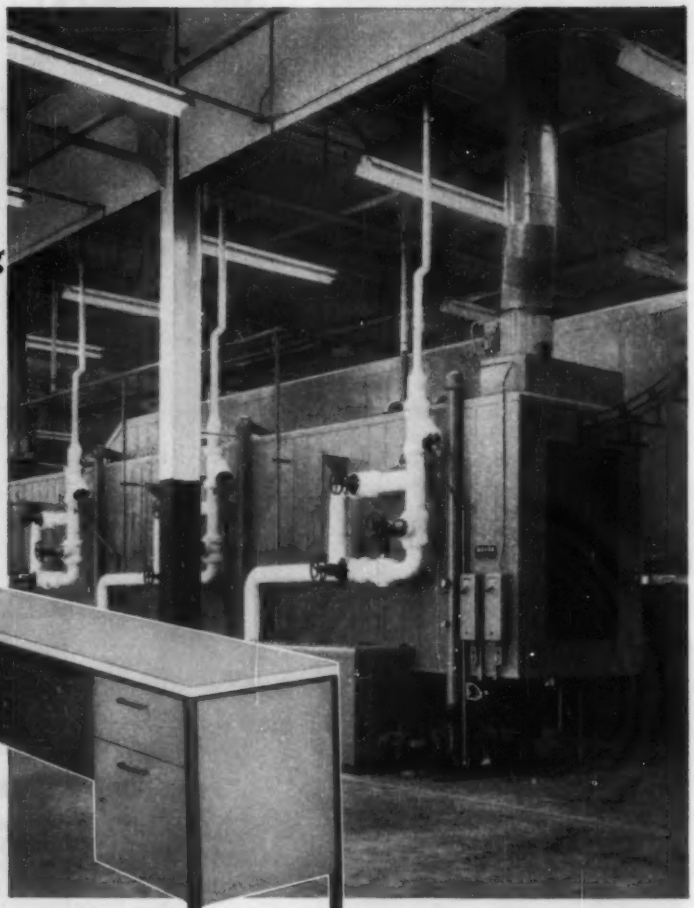
METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

Continuous feeding can be your answer to greater processing efficiency. Request Bulletin 32-R2. Write **B-I-F Industries, Inc., 527 Harris Avenue, Providence 1, Rhode Island.**

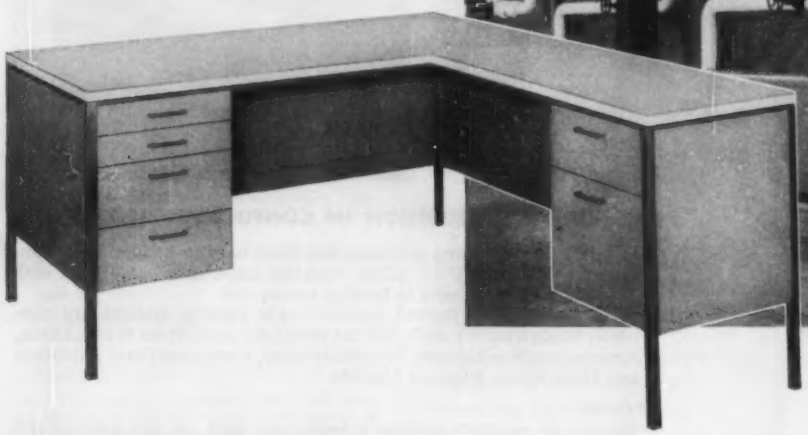
Circle 735 on Page 19

Quality metal products deserve
"the finishing touch" of Mahon

another
example . . .
fine office furniture from General Fireproofing



below: one of GF's new 1000 Series desks, part of a striking, new functionally designed business furniture line. At right: a stage of the complete finishing system designed and built by Mahon for GF's San Luis Obispo, Calif. plant.



Production finishing is the application of coatings of a specified quality at highest efficiency .That also sums up the business of Mahon's Industrial Equipment Division and they have learned it well . . . for over forty years . . . in hundreds of installations . . . for all types of finishing. Mahon metal-cleaning and metal-finishing systems will prove your best investment regardless of initial cost. In this highly specialized, multi-process area, can you afford less than the best for your quality products? Find out how Mahon's 'finishing touch' can improve your products . . . your costs . . . your sales. Call in Mahon.

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- Finishing Systems
- Metal Cleaning Equipment
- Painting Facilities—spray, dip and flo-coaters
- Drying and Processing Ovens
- Special Plant and Production Equipment

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MAHON

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Computer Characteristics

Charles W. Adams Associates Inc., 142 The Great Rd., Bedford, Mass.—brochure—Chart contains data on the salient features of forty-three general purpose, stored program electronic digital computers. It covers general characteristics, internal speeds, magnetic tapes, peripheral input and output equipment, and special features of these various computers.

Circle 470 on Page 19

Test Equipment

Control Engineering Co., Subsidiary, Jervis B. Webb Co., 8007 Joy Rd., Detroit 4, Mich.—6 page pamphlet—Line of precision test equipment for industry is pictorially covered in this bulletin. Featured is universal and combination test equipment employing hydraulic, electronic, pneumatic, and mechanical components. Illustrations include a dynamometer console, automatic transmissions tester, distribution transformer test, universal hydraulic bench, portable hydraulic oil printer, and balancing and hot engine test.

Circle 471 on Page 19

Numerical Control Programming

Boeing Applied Computing Services, 3801 S. Oliver, Wichita, Kansas—8 page bulletin—Data are contained in this booklet on a computer-assisted programming system designed to provide control tapes for numerically controlled machines. Designated as Waldo, this system employs digital computers. Features of the programming service are listed. Information is provided on a training course now being offered in this area of numerically controlled programming.

Circle 472 on Page 19

Electronic Equipment

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.—576 page catalog—Catalog 200A describes over 48,000 items of electrical and electronic parts and equipment made by over 400 manufacturers. It includes an extensive listing of items that can be used to fill industrial research, production, and maintenance requirements such as transistors, meters, electronic tubes, ultrasonic cleaning equipment, test sets, relays, switches, wire and cable, counters, program clocks, radio communication equipment, closed-circuit TV systems, and photoelectric components. Data are given on a line of over 60 electronic kits. A technical books section lists publications covering all phases of electrical, electronic, and radio engineering.

Circle 473 on Page 19

Terminals and Connectors

Electric Terminal Corp., P. O. Box 2217, Providence 5, R. I.—28 page catalog—Data are contained in Catalog 60 on a line of terminals and connectors. Also included are illustrations of terminal attaching machines (electric and air pressure actuated) with descriptions of feeder mechanisms. Terminal machines use cold crimping, welding, or banding methods for attaching blades to electric wires. Also provided are reference charts for wire sizes, stud and stud hole sizes, and decimal equivalents.

Circle 474 on Page 19

Precision Switches

Control Switch Div., Controls Co. of America, 1420 Delmar Drive, Folcroft, Pa.—12 page booklet—Catalog 110 gives details on a line of basic precision switches. Definitions of terms applicable to this line of switches are provided. Sub-subminiature, subminiature, single pole, double pole, and triple pole switches are discussed. Schematic diagrams illustrate construction features of the various models.

Circle 475 on Page 19

Open-Back Inclinable Presses

Federal Press Co., Division Street, Elkhart, Ind.—20 page booklet—Line of open-back inclinable presses, ranging in capacity from 7 to 125 tons, is described in Catalog 1015-4-60. Data are given on both geared and flywheel types. Also described are friction-type air clutches, chain or gear-driven dial feeds, and special presses.

Circle 476 on Page 19

Timing Belt Drives

T. B. Wood's Sons Co., Chambersburg, Pa.—8 page bulletin—Bulletin 21103 provides information on five steps leading to the selection of timing belt drives. It includes five sets of curves for drive-width selection as well as a table of application service factors. The method of computation used is illustrated by a sample problem, namely to connect a 15 hp, 1750 rpm, squirrel-cage motor of NEMA design B and normal torque, to a turret lathe to operate at 875 rpm.

Circle 477 on Page 19

Automatic Assembly

Ferguson Machine Corp., 7818 Maplewood Industrial Court, St. Louis 17, Mo.—8 page bulletin—Catalog 602 contains data on a new approach to automatic assembly. Featured is a standard rotary transfer machine which includes a center turret for placing parts at the working areas of an indexing dial. Dimensions and design data are given for standard cam actuated work station mechanisms. Other examples show in-line assembly machines being used to assemble a variety of parts.

Circle 478 on Page 19

Arc Welding Equipment

Hobart Brothers Co., Box DM-144, Troy, Ohio—6 page pamphlet—Data on a line of automatic and semiautomatic arc welding equipment are contained in this bulletin. Details are given on inert gas, carbon dioxide, and submerged arc welding heads. Typical applications of welding are illustrated. Constant voltage power units of 500, 900, and 1200 amperes are discussed and illustrated.

Circle 479 on Page 19

Hose Fittings

Lenz Co., Dayton 1, Ohio—12 page booklet—Catalog contains data on reusable low pressure hose couplings, union swivel adapters, hose assemblies in 1 and 2 rayon braid with reusable couplings, oxygen and acetylene couplings and connectors, paint spray air hose couplings and connections, male and female hose stems, joiners, adapters, hex pipe nipples, and pipe reducing connectors. The various items described are also illustrated.

Circle 480 on Page 19

Static Time Sequencer

Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N. Y.—4 page pamphlet—Data are contained in Bulletin

S-1023 on a static time sequencer applicable to industrial process control. Device is a self contained programmer which provides control/power signals for automatically performing test operations in sequence. Features described include a master magnetic clock, remote three-digit indicator, and interchangeable logic modules.

Circle 481 on Page 19

Flexible Shaft Assemblies

Kupfrian Mfg. Corp., 150 Prospect St., Binghamton, N. Y.—12 page booklet—Catalog 6094 illustrates and describes a line of light duty flexible shafts and flexible shaft couplings. Various types and sizes of standard units as well as component parts such as end fittings, core sizes, and casings are listed. Typical core properties are given. Design techniques for assisting engineers in applying flexible shaft assemblies are discussed.

Circle 482 on Page 19

Terminal Blocks and Switches

Kulka Electric Corp., 633-643 S. Fulton Ave., Mount Vernon, N. Y.—36 page catalog—Catalog 16 contains information regarding products and developments in both terminal blocks and switches. Complete mechanical and electrical information is given on all products. The catalog incorporates data on the latest plastic insulating materials as well as the various terminal block configurations. Barrier type terminal blocks are listed with all available hardware for each size. Also included is information on an insulating strip that provides extra dielectric strength between the terminal hardware and the chassis on which the terminal block is mounted.

Circle 483 on Page 19

Grinding and Polishing Machines

Hill Acme Co., 1201 W. 65th St., Cleveland 2, Ohio—28 page catalog—Data are given in this catalog on a line of two-roll vertical abrasive belt grinding and polishing machines, applicable to processing both ferrous and nonferrous materials. Three basic types—pinch roll, hydraulic table, and coiler—are described. Accompanying each description are illustrative photographs. Design features of the two-roll vertical head, main drive spindle, and belt centering device used by all the machines are given.

Circle 484 on Page 19

Servo Valves

Hydraulic Controls Co. Inc., 217 California St., Newton 58, Mass.—2 pamphlets—Applications, features, and specifications for two electrohydraulic servo valves are listed in Bulletin SS102 and Bulletin CO-5. Model SS102 servo valve is designed to meet the requirements of industry for a rugged, reliable, and serviceable control valve while still retaining the dynamic response required in precision control systems. It is a single stage, spool type, flow control hydraulic amplifier available for three or four-way operation. Model CO-5 valve is a precision mechanical four-way servo valve designed for use in follow-up positioning systems. Installation drawings of the valves are provided.

Circle 485 on Page 19

Switchgear

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.—20 page booklet—Data on a line of 4160-volt, metal-clad switchgear are given in Bulletin 2801-2A. Comprehensive information is included on the complete line of indoor and outdoor equipment—both minimum depth and walk-in types. Line is available in ratings through 3000 amperes continuous current and 250 mva interrupting capacities. Design features of the equipment such as a stored energy closing, a closed door horizontal drawout mechanism, and an ironless blow-out coil are outlined. Sections of the bulletin provide drawings, dimensions, preferred locations, and arrangements of the various circuit elements for both types of switchgear. Panel layouts and dimensions for standardized units are provided as well as charts and tables for detailed engineering evaluation.

Circle 486 on Page 19

Scrap Handling Systems

Gifford-Wood Co., Hudson, N. Y.—4 page pamphlet—Bulletin 900 contains data on how custom-engineered chip and scrap handling systems have provided substantial advantages in four different manufacturing plants. It points out, with case history examples, that automatic removal of

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chips and trimmings can mean reduced manhours, increased production, higher salvage prices, more usable floor space, and improved plant safety. Described and pictured are standard components which can be tailored to solve individual handling problems.

Circle 487 on Page 19

Damping Materials

Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass.—6 page pamphlet—Data on products that combine visoelastic damping materials to products to produce rigid highly damped structures are contained in Bulletin 60-10. These fabrications, designated Rigidamp, reduce the resonant-vibration response that all structures normally exhibit when subjected to shock or vibration excitation. Their applicability wherever vibration in a structure must be minimized without adding excessive weight or space is discussed. Oscillograms showing the response of solid aluminum and visoelastic-damped aluminum beams to shock excitation at same amplitude and frequency input are included.

Circle 488 on Page 19

Conveyor Lubricators

Olsen Mfg. Co., 4622 Delemere Blvd., Royal Oak, Mich.—4 page pamphlet—Data are contained in this bulletin on a line of conveyor lubricators for injecting oil or grease into wheel bearings in trucks, dollies, and pallets used with floor conveyors. These lubricators, designated Lub-Matics, have been designed for use under adverse circumstances involving heat and dirt conditions. They are available as standard models for use in quarries, foundries, for coal handling, mining, and other similar heavy duty applications. Five injector nozzles replace conventional single head nozzles reducing the workload of each nozzle by 80 per cent. Photographs illustrate models available.

Circle 489 on Page 19

Automotive Silicones

Dow Corning Corp., Midland, Mich.—8 page bulletin—Data are given in Bulletin 1-118 on how silicones in various physical forms are helping designers of automobiles, trucks, and other land vehicles solve some of their most difficult engineering problems. Applications for silicone products in production equipment and as aids to manufacturing and maintenance are also outlined. How the properties and forms of silicones combine to make possible new concepts and new freedom in design engineering are explained. Silicone rubber, designated Silastic RTV, that vulcanizes at room temperature is discussed.

Circle 490 on Page 19

Thermocouple Components

Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.—32 page catalog—Line of thermocouple fittings, pressure sealing glands, and thermocouple accessories are covered in Catalog 1890. Operational details, specifications, and construction features of the various units are given. Photographs are included for each of the products covered.

Circle 491 on Page 19

Surface Area Measurement

Instrument Div., Perkin-Elmer Corp., Norwalk, Conn.—4 page pamphlet—Data are given in this brochure on an instrument for accurate measurement of surface areas of solids. Designated as Model 212 Sorptometer, this device is applicable to such fields as petroleum refining, research studies, cosmetics, pigments, clay and ceramics, fertilizers, abrasives, drugs, and atomic energy. Measurements made with this instrument are based on fundamental adsorption principles and can be directly correlated with previously acquired data. A schematic flow diagram of the unit is provided.

Circle 492 on Page 19

Precision Punches

Pivot Punch and Die Corp., North Tonawanda, N. Y.—32 page catalog—Catalog 700 includes a complete line of shoulder punches, interchangeable ball seat punches, pilot punches, set screw punches, die buttons, and punch retainers. Shoulder and ball seat punches are offered in a wide selection of shank sizes and over-all lengths with round, square, oval, or rectangular punch points in standard stocked fractional sizes or decimal sizes. Punches are available in choice of carbon vanadium tool steel or in high speed steel. Slug ejector punches are available in a choice of three types, in all point shapes and shank styles. Photographs are used to illustrate the various items. A complete price list of the items is also included.

Circle 493 on Page 19

Pneumatic Controllers

Bristol Co., Waterbury 20, Conn.—6 page pamphlet—Data on a line of indicating pneumatic controllers are contained in Bulletin DM058. Series 624 features an advanced design control unit. Specifications for the instruments are given, and models are listed for controlling pressure, vacuum, liquid level, flow, temperature, and humidity.

Circle 494 on Page 19

Magnetic Core Memories

Computer Control Co. Inc., 983 Concord St., Framingham, Mass.—8 page bulletin—Line of random access magnetic core memories is subject of this booklet. Applications include use for information storage in digital computers and other special purpose digital systems, automatic control, information processing and format control, analog-to-digital conversion, automatic checkout programming, and numerical data processing. Details of several different memories are given. Dimensions of each memory are shown. Descriptions of the data insertion (clear and write) and data extraction (read and regenerate) cycles plus a block diagram of a typical memory system are included.

Circle 495 on Page 19

Spur Gears

PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.—36 page handbook—Booklet 5 outlines specifications established on low inertia, custom made, certified military-type, fine pitch spur gears. Details are given on a newly developed

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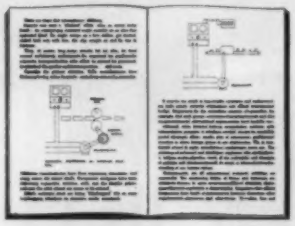

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Circle 739 on Page 19

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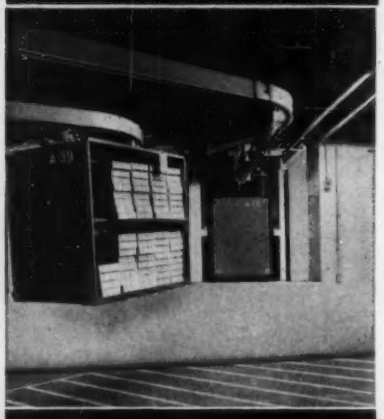

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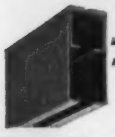

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Circle 740 on Page 19

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Circle 496 on Page 19

Metal Forming

Spincraft Inc., 4122 W. State St., Milwaukee, Wis.—1 page bulletins—Monthly bulletins entitled "Notes for an Engineer's File" cover case histories of a broad variety of metal spinning jobs, complete with technical data. Unusual spinning jobs in industrial, agricultural, recreational, and other fields are covered. These bulletins cover production of such parts as hog feeders, stainless steel plungers, milk-filler tanks, spun aluminum gondola parts, and pin setting machines. Illustrations accompany each discussion.

Circle 497 on Page 19

Vibrating Feeders

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—6 page pamphlet—Folder 2770 contains data regarding straightline vibrating feeders which incorporate a Synchromatic vibrator for high-capacity, controlled feeding of heavy and highly abrasive bulk materials. These materials include iron and nonferrous ores, coal, rock, slag, shale, clinker, gravel, and foundry sand. The feeders have been applied on such items as transfer conveyors between belt conveyors, shakeout sand hoppers to belt conveyors, track hoppers to belt conveyors, and batch cars to weigh stations. Two models are available in 30 sizes with capacities up 1350 tons per hour.

Circle 498 on Page 19

Automatic Presses

Havir Mfg. Co., 444 N. Cleveland, St. Paul 4, Minn.—8 page bulletin—Data on a line of 5 to 200-ton automatic presses for long run or continuous small parts stamping jobs are given in this booklet. Various models are illustrated and specification details for them are provided. Details are also furnished on press features such as cylindrical cams, safety shutoffs, specially designed feeds, and air clutch, and spring applied brakes.

Circle 499 on Page 19

Rotary Benders

Wallace Supplies Mfg. Co., 1304 Diversey Parkway, Chicago 14, Ill.—16 page booklet—Line of rotary benders for the forming of tube, pipe, bars, structural shapes, and channels is subject of this booklet. Illustrated are many types of mechanical and hydraulic bending machines for forming from steel, stainless steel, copper, brass, and aluminum.

Circle 500 on Page 19

Unit Substations

General Electric Co., Schenectady 5, N. Y.—32 page catalog—Bulletin GEA-3592L gives information on the features, operation, and application of selectively co-ordinated load center unit substations that provide continuous power for ac distribution systems rated at 300 to 3000 kva, 600 volts and below. It discusses and compares types of load center arrangements and explains how selective co-ordination of load centers can be provided on any of the four basic industrial and commercial building power distribution circuits. Photographs; line, system, and schematic diagrams; time-current curves; application and rating tables; and dimensional drawings are included.

Circle 501 on Page 19

Electromechanical Devices

Carmody Corp., 2360 Wehrle Drive, Buffalo 21, N. Y.—4 page pamphlet—Line of electromechanical components and assemblies is covered in Bulletin CFPF4. Included in this line are clutches, brakes, and dummy and activated instruments. Applications and optional features of the subminiature servo, hysteresis, and industrial friction series of the clutches and brakes are listed.

Circle 502 on Page 19

V-Belt Drives

Service Div., Maurey Mfg. Corp., 2907 S. Wabash Ave., Chicago 16, Ill.—24 page handbook — Catalog SW-1 describes a wedge-type, V-belt drive that is capable of reducing drive size as much as 50 per cent with no loss in horsepower capacity. This catalog includes engineering data pertinent to proper drive selection and installation. Drive selection tables, horsepower ratings, sheave dimension tables, and installation instructions covering belts, sheaves, and bushings are given.

Circle 503 on Page 19

Servomotors

Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.—14 page booklet—A report on the electrical and mechanical characteristics of Size 8 Servomotors under various environmental conditions is given. Purpose and nature of the study, apparatus employed, actual test procedures, data, results, and conclusions are included.

Circle 504 on Page 19

Solid Lubricants

Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.—24 page handbook—This booklet discusses boundary friction and the use of solid lubricants to reduce friction and wear under heavy loads and at high temperatures. The major advantages of molybdenum disulfide solid lubricants are discussed. These lubricants are available in powder form, as greases, as resin bonded coatings, as dispersions, or in special forms.

Circle 505 on Page 19

Hydraulic Equipment

Vickers Inc., Div., Sperry Rand Corp., Administrative and Engineering Center, Detroit 32, Mich.—74 page catalog—Catalog 5001C describes a line of hydraulic products applicable to the industrial, marine, and ordnance fields. This line includes power packages, servo valves and systems, vane pumps, piston pumps, pressure controls, flow controls, directional controls, control assemblies, hydraulic motors, variable speed drives, hydraulic cyl-

inders, and accessories. Each specific family of products is described in a separate section. Photographs, drawings, tables, curves, and typical circuit diagrams are included.

Circle 506 on Page 19

Engineering Service

Strand Engineering Co., 1354 N. Main St., Ann Arbor, Mich.—12 page booklet—This booklet is designed to give management men information on the application of electronic automation as a cost reduction tool for manufacturers and processors. Entitled "Breaking the Cost Barrier with Electronic Automation," this booklet covers such fields as heavy industry, pharmaceutical, aircraft, radio, nuclear energy, automotive, business machines, and rubber. A case history of a counting accuracy problem is presented.

Circle 507 on Page 19

Rotary Switches

Ledex Inc., Dayton, Ohio—14 page booklet—Catalog D-460 describes the 150,000 Series of hermetically sealed rotary switches. Details are provided on 3072 standard designs, including dimensions, drawings, mountings, receptacles, and wiring. Complete control and performance data, environmental conditions, duty cycles, voltage codes, and approximate hold-in resistor values are also included.

Circle 508 on Page 19

Package Conveyor Belts

B. F. Goodrich Industrial Products Co., Akron, Ohio—2 page pamphlet—Data sheet 2550 describes a line of package conveyor belts featuring a ribbed design. The belts are self-cleaning and designed for use with packages that range from very heavy to extra lightweight. Every 18 inches, a rib raised higher than the rest stops lightweight packages from sliding. Other types of conveyor belts are illustrated and described.

Circle 509 on Page 19

Automatic Gradient

Technicon Chromatography Corp., Saw Mill River Rd., Chauncey, N. Y.—4 page pamphlet—This bulletin gives data on a device which produces any gradient of pH or concentration for eluting a chromatographic column and is available for use with all solvents. The brochure tells how the device, designated Autograd, automatically provides a gradient of an infinite number of points of eluting material change rather than a series of discrete plateaus. Details are given on the use of this gradient with an automatic analyzer to provide a continuous automatic system for chromatographic analyses. Performance charts and design and construction features are included.

Circle 510 on Page 19

Temperature Controller

Atlantic Pyrometers Inc., 190 Warburton Ave., Hawthorne, N. J.—4 page pamphlet—Data are given in Bulletin 0035 on an indicating pyrometer controller. Unit can be calibrated in any standard range for use with thermocouples from −300 F to +3000 F and in special ranges for other variables and transducers producing dc millivolt signals. Measuring system of the unit utilizing a d'Arsonval permanent magnet and moving coil mechanism for measurement of output millivoltage is discussed. Diagrams indicate operation and application.

Circle 511 on Page 19

Turret Lathe

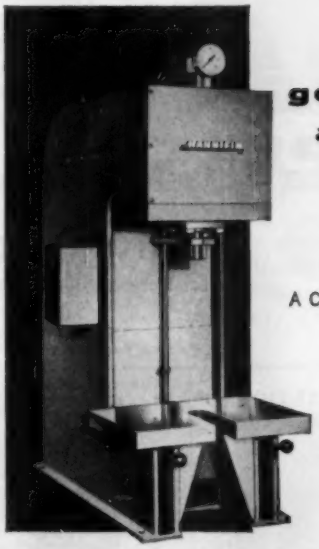
Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—14 page booklet — Automatic turret lathe designated Model 3E-15 is subject of Bulletin 177. Some of the feataures described include: Selector-switch cross slide control, control drum, speed and feed changes, precision spindle, centralized automatic lubrication system, and dual coolant systems. Details are also given on a system of tape control for automatic machine programming applicable to the lathe.

Circle 512 on Page 19

Case Sealer

J. L. Ferguson Co., Sales Dept., P. O. Box 1226, Joliet, Ill.—8 page bulletin—Unit designated Packomatic Omnimatic-Rotopress, designed to feed, glue, and seal cases of varying dimensions, is subject of Bulletin 100-60. Operating details are explained and illustrated as are various models. Diagrams are used to indicate the operation of a single and double indexing unit.

Circle 513 on Page 19



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Circle 741 on Page 19

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Circle 742 on Page 19

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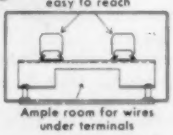

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Circle 743 on Page 19

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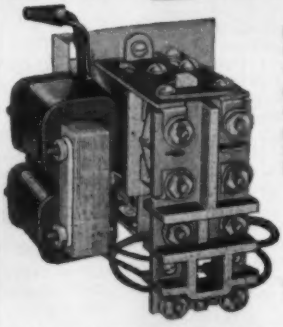

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Circle 744 on Page 19

AUTOMATION abstracts

FUTURE SPECIAL MACHINES

By M. ZAJAC
Vice President, Engineering
Buhr Machine Tool Co.
Ann Arbor, Mich.

HISTORICALLY, production engineers and management have been faced with a choice concerning the selection of machine tools—general-purpose or special-purpose. General-purpose machines do a specific operation on any part; special-purpose machines do one or more operations on one part. Because of this, the general-purpose machine is completely flexible. It can machine any workpiece that can be maneuvered into position under its tools.

But, a general-purpose tool does not lend itself to automatic operation. If long runs are anticipated, some special loaders, unloaders, jigs, and fixtures can be developed and applied to general-purpose machines, but true automatic operation is not worthwhile. General-purpose machines are comparatively inexpensive to purchase but may have high production costs for labor, handling, etc.

For automatic operations, special-purpose machines have to be developed. Such machines can turn out huge quantities of the same part with high accuracy. They are usually economical to run but have a high initial cost because they have to be engineered to perform one job.

Even with all these conflicting desires, production engineers can study requirements and come up with the best answer for a particular set of conditions at a particular time. Conditions, however, do not stay the same. A choice that was correct and economical a year ago may now severely limit the company in various respects. A large capital investment usually means that both production and design departments will have to live with the production equipment for a long time.

Future Machine Class

The machine tool of the future will probably be unlike anything used today. The goal is a new class of machines that could best be described as universal special-purpose machines. It is possible to anticipate the class, but it is not possible to anticipate the actual achievement or details of particular machines.

As a first step in that direction, there is a new type of machine tool that can be called the special general-purpose machine. These machines are developed to do several operations on families of related parts. Even though individual part-production runs may not be large enough to justify automation equipment, the total number of parts is large enough for this justification.

Machines have been developed in which much of the setup can be accomplished by turning a switch. Such machines process families of parts that are strongly related but which have real differences. To prevent mistakes during setup—and setup changes are rather frequent for workpieces that individually are not produced in volume—the machine cycle can be set merely by shifting a selector switch to the number of the part. This design philosophy might be called "automation to the second power."

Volume of Space Idea

Actually, any machine that does more than one operation with more than one tool is "surrounding" a volume in space. Operations of any type can be done anywhere within this volume. It would be possible to place a workpiece at any point in this volume and operate on it with any of the tools that could reach it.

To translate this abstract idea into a practical machine tool requires the inclusion of a pallet or table that can carry the part along the length of the volume described in space. It is not too important how the pallet moves. It can move continuously, or it can move intermittently. It can move only in one direction, or it can be moved forward and then backward. If necessary, the pallet could also be moved to either side.

PART NUMBER	STATION NUMBER																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	H_1				H_1				H_2	H_2	H_3	H_2		H_3	H_2						LOAD AND UNLOAD
2				H_1				H_1	H_2	H_2		H_2	H_3		H_2		H_3				
3		H_1					H_1		H_2	H_2		H_2 H_3			H_2						
4			H_1		H_1					H_2		H_2			H_3			H_3			
5				H_1		H_1				H_2		H_2				H_3			H_3		
6			H_1				H_1		H_2	H_2		H_2 H_3			H_2 H_3						
EFFECTIVE SHOT-PIN	A	B	A	B	A	B	A	A	A	A	C	C	C	C	C	D	C	C	D		
DISTANCE BETWEEN STATIONS (INCHES)	3	1¼	1½	1½	1¼	1¼	3	20½	10	7	3	3	4	3	1⅜	1⅜	8	1⅜	1⅜		
	TOTAL = 90 INCHES																				

Fig. 1—Special cycle sequence chart indicates operations for 20-station machine to process six different workpieces having family characteristics. Much of the setup for part changeover may be accomplished by turning a switch.

The volume of space now has a means for introducing a workpiece. It needs some tools that can cut, drill, mill, press, gage, assemble, etc. Single tools or groups of tools could be carried on heads or rams that can move in and out, or up and down. If these tool heads and their related power supplies are of modular design, they can be arranged in any manner around the

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volume.

The arrangement of the machining heads would be dictated only by the production needs of the moment. Each tool head would be adjustable so that it could be applied at any point within the volume.

Inexpensive Control

There are many systems of control that could be applied to this machine tool built around a volume in space. Mechanical controls, electronic controls, tape controls, and various combinations could be applied to these components so the workpiece would describe the proper path through the machine, and the tools would operate on the workpiece at the proper times.

To broaden the areas where such a machine could be used, controls will be considered for minimum expense, maximum reliability, and automatic operation. So that time will not be wasted, the controls should be able to route the workpiece to only those heads that will perform operations on it. If this is not possible, then, at least, the workpiece should not have to stop at a working station where nothing will be done to it.

The first two requirements for any control system for machine-tool application are: 1. To position the workpiece accurately. 2. To keep the cycle progressing so long as conditions are normal.

Locating a cutting tool by stopping a drive motor is not sufficient to meet modern production needs. To obtain accuracy, it is necessary to include a shot pin in the system. By positioning limit switches along the length of travel and by having several shot-pin holes in a rail attached to the bottom of the pallet, working stations can be accurately identified. By using two rows of holes and two sets of two shot pins, the carrier pallet can be stopped at any point.

Before the stations can be set and the shot-pin holes bored, the work required on each of the family of parts has to be determined. Tool requirements and work locations have to be set up so that all necessary operations can be done on each part. One good method is to make a special plot for the machine, *Fig.* 1. With this logical recording of the parts, operations, and machine stations designated, errors should not creep in.

After this "map" has been completed for the basic family of parts, it may be possible to add other workpieces. Depending on the operations required and the configuration of a potential workpiece, it will be readily apparent whether the part can be made on the machine.

When all of the workpieces have been selected and scheduled, it is then possible to locate dogs; assign machine-head movements; locate and connect limit switches; and finish the machine for production. A master selector dial is used to select the cycle for the part being produced. This is done by making some limit switches effective and others noneffective. As a dog contacts an effective switch, the pallet stops and the machining cycle follows. Nothing happens as a dog passes over a noneffective switch. The pallet simply continues its travel.

A machine designed by these principles is more versatile than most of the production equipment in use today. There is no limit to the number of part designs that can be handled by such a machine, as long as each part can be processed by the tools available and can be positioned in correct relation to these tools.

Circle 745 on Page 19

Capital investment is protected, too. If the family of workpieces made by this machine is no longer needed, the machine does not have to be scrapped. Electrical control circuits, dogs, limit switches, etc., can be revamped to encompass an entirely new family of parts. The shot-pin system can be reworked to give accuracy to new station locations. Tools can be changed in size, in location, or both, so they can operate on the new parts. Machining heads can be rearranged. New heads can be added if needed.

From a paper entitled "Built-In Production Programming Saves Money" presented at the 28th Annual Meeting of the American Society of Tool and Manufacturing Engineers, Detroit, April, 1960.

NEW WELDING PROCESSES

By J. J. CHYLE
Director of Welding Research
A. O. Smith Corp.
Milwaukee, Wis.

IN THE FIELD of welding we have made marked advances in the development of new welding processes and new welding concepts. The question might be raised as to why we need new processes and why the drive for further development in the welding field. The answer is simple. New metals are commercially available and must be fabricated, which in many cases can only be done effectively by welding. These newer materials have characteristics and properties which require new methods of processing and new welding procedures.

Another reason for new welding processes is the continuous search for lower costs, without sacrificing quality. Cost is probably the most important competitive factor to be considered, since we are living in a competitive world.

If we consider only the field of fabrication by welding, we have three broad groups of welding processes; namely, pressure welding, fusion welding, and brazing. The selection of any process will be governed by such factors as the type of metal to be joined, design of weldment, cost of welding, and the engineering and service requirements involved.

Pressure Welding

Pressure welding is a term applied to a group of related welding processes, in which the use of force is of primary importance in obtaining the coalescence of metal, which is performed usually over the entire area of the abutting surfaces. The coalescence may be produced either with or without the application of heat.

Ultrasonic Welding: In this process the energy to effect a weld is derived from the use of special equipment, using elastic vibratory energy in the joining of metals. Both spot and seam welding of metal sheets can be accomplished. At the present time this process is more or less limited to the joining of thin sheet ma-

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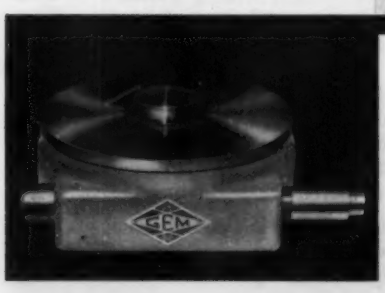

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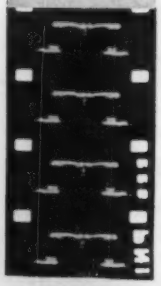

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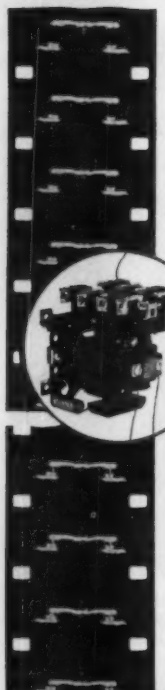

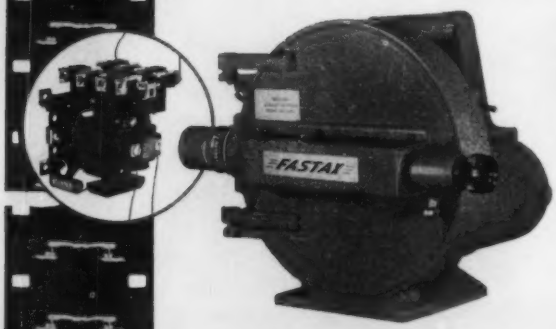

WRITE for new descriptive literature.

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terials. With further developments in the equipment for ultrasonic welding, it is expected that the range of thickness will be extended.

High-Frequency Resistance Welding: This process depends on the fact that high-frequency current can be brought directly into the object to be heated by contact, as well as by induction. This process is applicable to a wide variety of metals. Some of the highly reactive metals have been successfully welded with this process, using inert gas for shielding. In addition to the welding of similar metals, combinations of dissimilar metals have also been welded successfully. One of the advantages of this process is the high speed that can be obtained. Another is the narrow heat-affected zone obtained, due to the relatively narrow band of heating.

Foil-Seam Welding: This is a resistance welding process for making butt-type joints in flat strips or sheets, using a foil on either the top or bottom or both surfaces over the butt joint. In this welding operation a small nugget is formed which gradually increases in width. The thin foil strip is pressure welded into the fused area.

An advantage of this process is the high speed of welding. Another advantage is the freedom from distortion, with the joints being flat and requiring little, if any, final dressing of the weld metal. This process has future potentialities because of lower finishing costs and dimensional uniformity.

Magnetic-Force Welding: The basic principle of magnetic force welding is the synchronization of the force or pressure by means of coupling this force with magnetic force, created by the welding current. This new principle of force application allows extremely accurate synchronization of the electrode force and the welding current.

The magnetic-force welder is generally of conventional design and a variation of a direct-acting piston or ram-type spot welder, which has been redesigned to accommodate electromagnets for the application of pressure. In most of the applications for this type of weld, the welding time is of short duration, varying from one-half cycle to a few cycles. The advantage of the magnetic-force welding process is that it can be used for the welding of high-conductivity metals to each other, and also to carbon steels.

Percussion Welding: Percussion welding is a resistance-welding process in which the weld is made in an exceedingly short period of time over the entire area of the metals to be joined. The weld can be produced either by a rapid discharge of electrical energy from a stored-energy type of power source, or by the rapid dissipation of current with a standard 60-cycle alternating-current source. The principle of operation in this process is that the part to be welded has a small pinpoint type of projection formed or coined into it, which projection is instantaneously vaporized upon contact during the downtime movement of the electrode. Advantages of this process are the welding of large contact areas with the smaller capacity machines and the high quality of weld that is produced.

Friction Welding: Friction welding is a pressure-welding process which was described in Russian literature. The principle of the operation is based on heat

produced by friction of rapidly moving parts. In the initial tests in the development of this process, the parts were held and rotated in a lathe that was modified to incorporate the application of pressure.

After the temperature is reached, rotation is stopped with the pressure being maintained or sometimes increased, until the completion of welding, after which the weld is cooled in air. A variety of materials are reported to have been welded. Limitation of this process at the present time is to parts that are cylindrical in shape and that can be rotated. Some inherent advantages of the friction-welding process may be found in low cost of power requirements and high speed of operation.

Thermo-Pressure Welding: This is a process that can be considered in the field of solid-phase welding. In solid-phase welding the parts to be welded are under continuous pressure, and the metal is heated until complete or partial plastic flow is obtained.

The success of this process depends upon the cleanliness of the surfaces held under pressure, and the application of heat to produce a true pressure weld. With the thermo-pressure welding process it is possible to weld metals to semi-conductors and to other metals which would be difficult to weld by the fusion-welding process.

Diffusion-Bond Welding: Diffusion-bond welding may be defined as a pressure-welding process in which the metals to be joined are heated to temperatures below their solidus and are held under pressure for some length of time. No liquid phase is formed, and the bonding occurs by movement of atoms or intermetallic compounds across the interface on the surfaces, where intimate contact occurs.

At the present time diffusion-bond welding has been investigated for applications to only a few metal combinations, such as the joining of beryllium-copper alloys to Monel and other metals. However, this process appears to have promise for joining of many dissimilar types of metals and alloys which cannot be joined together by fusion welding.

Fusion Welding Processes

Fusion welding is a term applied to a group of related welding processes in which the use of heat is of primary importance in obtaining the coalescence of metal. The source of heat may be from electric energy, a chemical reaction between aluminum metal and metal oxides, or the combustion of gases and solid fuels. A few of the important new fusion-welding processes that have been developed within the past 10 years, and which appear to have promise for future applications, are described in the following text.

Electroslag Welding: One of the most recent developments in fusion welding is electroslag welding, first reported in Russia. Fusion of the electrode wire and the parent metal takes place in and under a molten-slag bath covering the metal bath from which the weld is formed. The electrode wire or wires are immersed in the liquid slag. This process is used primarily for welding of heavy sections.

One of the advantages of this process is the high metal deposition rate, which may be as high as 45 lb

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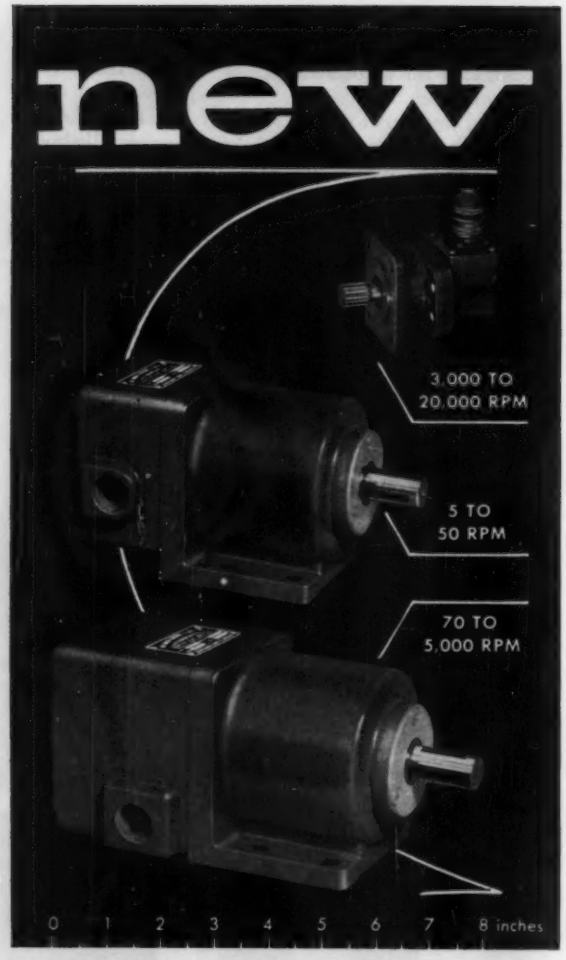

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of weld metal per hour per single wire. Another advantage is the high thermal efficiency that is obtained. One limitation of this process is the large heat-affected zone area adjoining the weld, and the coarse columnar structure of the weld-metal deposit.

Electron-Beam Welding: This welding process is based on the impingement of electrons on the workpiece in high vacuum. The electrons are emitted from a tungsten-wire filament, and are given a high degree of acceleration and velocity by a high-voltage potential between the cathode and the workpiece.

Because a high degree of vacuum is necessary to obtain electron bombardment, the operation is safe from contamination from oxygen or nitrogen of the atmosphere and from other foreign materials. In the operation of the electron-beam welding, the high temperatures which are developed vaporize some of the impurities in the parent material that is fused, with the resultant weld being much cleaner than the original base material.

One advantage is the absence of an electrode or an arc in close proximity to the welding area. Another significant advantage of this welding process is that the most reactive and refractory metals can be welded without contamination.

One of the outstanding characteristics of the process is the deep penetration, and tests so far have indicated that it is possible to obtain a depth to fusion width ratio of 2 to 1. One of the disadvantages of this process, when operating at the very high voltages, is the emission of penetrating short-wave radiation, which requires protection or shielding for personnel.

Arc Plasma: Arc-plasma type of heating produces extremely high temperatures ranging from 10,000 to 30,000 F. The basic principle consists of passing a gas through a chamber in which an arc is maintained. The flow of electrons from the cathode to the anode ionizes the gas, and the resultant bombardment causes the gas to be heated to extremely high temperatures. The ionized gases are forced through a nozzle opening, so that the heated gases have the appearance of a flame emanating from the end of the chamber. The energy transmitted is largely due to the ionization of the atoms in the vapor and gases, and also to the disassociation of the molucules, which results in liberation of large amounts of thermal energy.

The present application of the plasma torch is for spraying of metals and refractory materials. At the present time the arc plasma has been developed primarily as a source of heat, and while some equipment has been developed for metal and ceramic-material deposition, the process has a vast potential for future applications for fusion welding of metals.

Brazing

Brazing is a term applied to a group of welding processes in which coalescence is produced by heating to suitable temperatures above 800 F, and by the use of filler metal having a melting point below that of the base metals. The filler metal is distributed between the closely fitted surfaces of the joint by capillary attraction. There are several welding processes in the brazing group in which significant improvements have been made, mainly in the brazing alloys and in the

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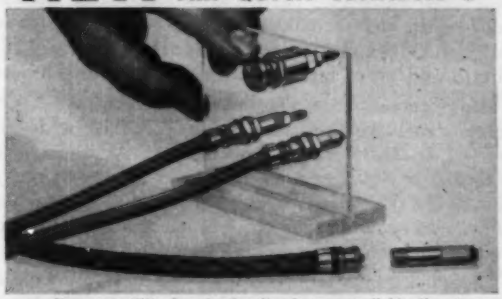

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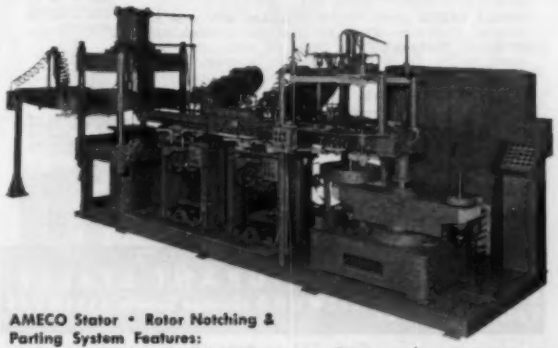

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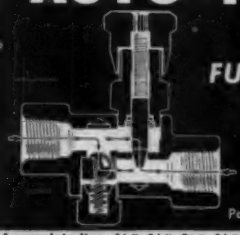

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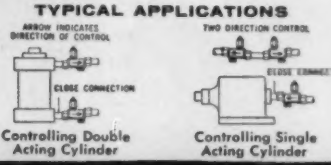

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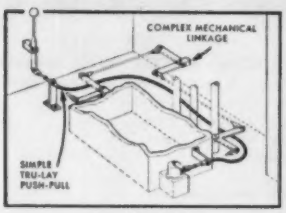

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heating methods used.

One outstanding brazing achievement is the development of what is commonly called the "sandwich-type construction," which is used on various parts of aircraft components. The brazing operation can be performed in a number of ways, such as furnace brazing with partial vacuum or an inert-gas atmosphere to prevent oxidation, and with graphite blocks to maintain the proper dimensional stability and flatness. The component parts to be brazed are enclosed in a metal envelope hemetically sealed around the edges, and the entire assembly is placed in a furnace to heat to proper temperature.

The advantage of the brazing process, as applied to honeycomb construction, is that it makes possible the welding or joining of extremely light sections in large areas, for high rigidity and strength. Another advantage is that large areas on panels can be brazed in one operation. Some of the problems involved in the brazing process as applied to sandwich construction are the limitations on the over-all size of panels to be welded, the problem of joining panel sections together, and the problem of inspection.

More Coming

We can also depend on new important developments in many of the established welding processes such as the metal-arc coated-electrode process, where we expect some radical improvements in quality and performance of the covered electrodes. These improvements will be in the low-hydrogen type of electrode, which will be nonhydroscopic and can be used without the present precautions regarding storage.

Welding power sources will also be radically improved in the future, as to their use in the various arc-welding processes. Of particular interest is the development of the new square wave ac power source, which has found distinct applications in the welding of aluminum and other metals by the TIG welding process.

Improvements have also been made in power sources for resistance welding, such as spot welding and seam welding, in which the control circuit has been modified so that it is self-correcting and adjusting. The energy for making the weld is controlled by an electrical computer system which determines the proper duration and current intensity to make uniform welds.

The development of many of the new arc-welding processes has resulted in high speeds ranging up to 4000 ipm, and the guiding of the arc is becoming an increasingly difficult problem. Several new principles for automatic guidance have been developed for high-speed welding.

Further developments on new welding processes, new welding power sources, and new concepts in welding are to be expected. The use of explosives for explosive welding has already been investigated and promising results obtained. Rocket-propellant solid fuel has also been investigated, and preliminary trial has shown that it is possible to use solid fuel for fusion welding.

From a paper entitled "New Welding Processes" presented at the Design Engineering Conference and Show of the American Society of Mechanical Engineers, New York, May, 1960.

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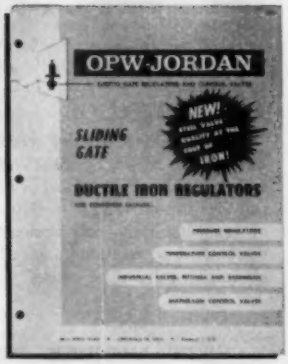

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Circle 758 on Page 19

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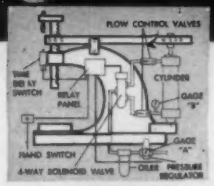
FOR CONTROLLED TIME DWELL OF AIR OR HYDRAULIC CYLINDERS



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- Holds dwell accurately to fraction of second
- Automatically re-sets
- Designed for millions of actuations

Pneu-Trol Time Delay Switch will hold any cylinder controlled motion or operation at a positive stop on either end of the stroke for ¼ to 60 seconds in 20 to 1 ratios. Simple, easy to adjust. Automatically re-sets after each actuation. Positive, controlled time dwell permits wider use of air or hydraulic power in automatic operations, increases accuracy of work by insuring split-second accuracy of time dwell. Available with many thrust linkages for left and right, down, up, or horizontal thrust. Write for Special Bulletin TDS-59

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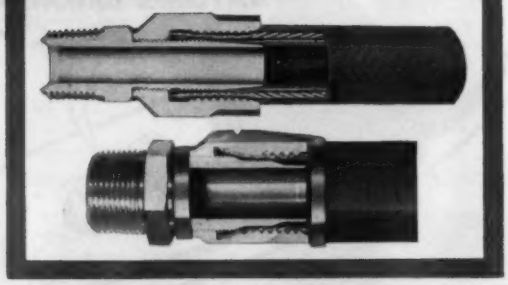

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Circle 760 on Page 19

AUTOMATION

new books

TEMPERATURE MEASUREMENT AND CONTROL

By W. F. Coxon; 314 *pages,* 5½ *by* 8½ *inches, published by the Macmillan Co., New York; available from* AUTOMATION; $12.00.

An introductory text on the subject of temperature control, this book discusses typical measuring and control instruments and their use in British industrial applications. The greater part of the book is concerned with a review of basic measuring devices, but a large variety of miscellaneous applications are briefly reviewed in the concluding chapter of the book.

PROGRESS IN AUTOMATION—VOL. 1

Edited by Andrew D. Booth, University of London; 231 *pages,* 5½ *by* 8½ *inches, published by Academic Press Inc., New York; available from* AUTOMATION; $8.50.

This is the first book in a proposed series to be devoted to reporting advances of interest to general and production managers. Included in Volume 1 are contributions by eleven British experts. Basic subjects covered are: Analog-to-digital conversion techniques, electronics in process control, point-to-point positioning control of a work table, and application of nuclear gages. Several chapters report on applications, including such subjects as machine tool control, steel strip rolling, and automatic inspection.

UNITS, DIMENSIONS, AND DIMENSIONLESS NUMBERS

By D. C. Ipsen, associate research engineer, University of California; 236 *pages,* 5½ *by* 8½ *inches, published by McGraw-Hill Book Co. Inc., New York; available from* AUTOMATION; $6.50.

This book is essentially a critique of the field of units and dimensions. It is the author's aim to show how an improved understanding of physical variables and physical relations can be gained through a thorough grounding in the theory of handling units and dimensions. Chapters on similitude, dimensionless relations, and dimensional analysis are included.

MAGNETIC AMPLIFIERS—PRINCIPLES AND APPLICATIONS

By Paul Mali, director of education and training, Electric Boat Div., General Dynamics Corp.; 101 *pages,* 5½ *by* 8½ *inches, paper bound, published by John F. Rider Publisher Inc., New York; available from* AUTOMATION; $2.45.

This book is intended primarily for technical aids, electronic technicians, and similar levels in industry. It presents a fundamental discussion of magnetic amplifiers along with basic principles governing their use in a variety of industrial systems.

MANAGEMENT ORGANIZATION AND THE COMPUTER

Edited by George P. Shultz, professor of industrial relations, and Thomas L. Whisler, associate professor of industrial relations, Graduate School of Business, University of Chicago; 257 pages, 6 by 9¼ inches, published by the Free Press of Glencoe, Illinois; available from AUTOMATION; $7.50.

This book reports the proceedings of a seminar sponsored by the University of Chicago's Graduate School of Business and the McKinsey Foundation. The purpose of the seminar was to investigate the effects of the technological changes in processing of business information. The report is divided into four major sections: Information Technology and Management Organizations, Technical Developments and Their Use By Management, Organization—Concepts and Problems; and Information Technology—Experience In Five Companies.

STATISTICAL PROCESSES AND RELIABILITY ENGINEERING

By Dimitris N. Chorafas, Booz, Allen and Hamilton International Inc.; 438 pages, 6 by 9 inches, published by D. Van Nostrand Co. Inc., Princeton, New Jersey; available from AUTOMATION; $12.75.

Essentially, this is a book that discusses the mathematics of reliability for the benefit of those who do not consider themselves to be mathematical experts. Early chapters are devoted to basic considerations of engineering statistics and statistical experimentation. Proceeding from these considerations the author discusses probability theory and related methods for solving engineering problems. The last two major sections of the book deal with quality control and reliability engineering in detail.

DIMENSIONAL CONTROL IN PRECISION MANUFACTURING

By John L. Gadzala, senior tool engineer, Pilotless Aircraft Div., Boeing Airplane Co.; 203 pages, 5½ by 8¼ inches, published by McGraw-Hill Book Co., New York; available from AUTOMATION; $7.50.

Technological forces at work today increasingly demand that the manner in which parts are produced be controlled by a competent engineering activity. One aspect is the selection of the most advantageous production method to be used. Concerned with this aspect, this book primarily covers the use of tolerance charts for dimensional control. Development of a typical production-machining process is described in detail.

HANDBOOK OF INDUSTRIAL RESEARCH MANAGEMENT

Edited by Carl Heyel, management counsel; 513 pages, 6 by 9 inches, published by Reinhold Publishing Corp., New York; available from AUTOMATION; $12.00.

As is pointed out in the preface, the results of industrial research have been tangible and spectacular, but, on the other hand, research is an area which has proved least amenable to effective management control. The purpose of this book is to review all aspects of the management of industrial research. The 17 chapters represent the thinking and experience of 33 contributors divided into major topics of: Management Perspectives; Research Perspectives; Accounting, Control, and Evaluation; Personnel Administration; and Research for Governmental Agencies.

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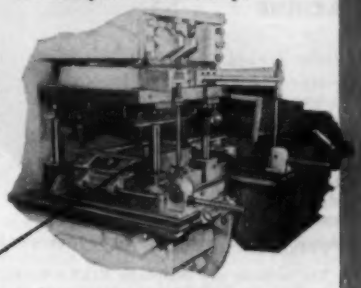

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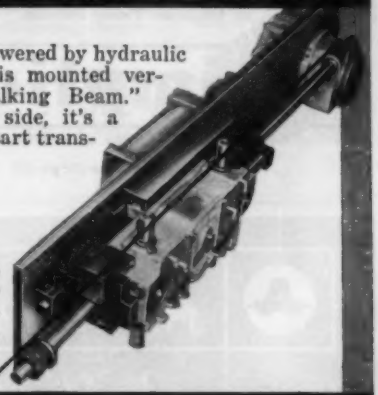

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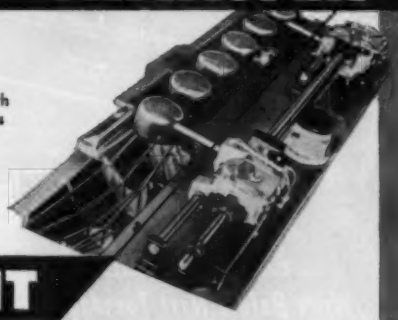

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CASE 2176-P

SMALL BLOWER

. . . We are looking for a manufacturer who can supply us with a small blower for use as an integral part of a new device. The unit need not develop pressures above 6 inches of water; volume need not exceed 20 cfm. The unit must be compact. An integral motor is preferred to a separate belt drive. Motor characteristics are either 110 volt or 220 volt, 60 cycle. . .

Consultant

CASE 2180-P

SAND UNLOADING

. . . I require information on a system for the unloading of dry sand from a 60-ton covered cement car. The sand is to be moved over a horizontal distance of 20 feet and raised approximately 30 feet to a storage bin. A quick-unloading low-maintenance system is preferred. . .

Senior Industrial Engineer

CASE 2178-P

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. . . We are interested in a source for an ink that can be stamped onto bare steel and aluminum chassis and painted chassis and which can eat into the metal or paint, marking it permanently. The stamp to be used with this ink should have changeable numerals. . .

Plant Mechanical Engineer

CASE 2177-P

SMALL PARTS FEEDER

. . . We have a need for parts feeders that will handle and feed parts 0.015-0.050 inch in diameter and 0.050-0.150 inch long. We would appreciate names of any manufacturers of such feeders. . .

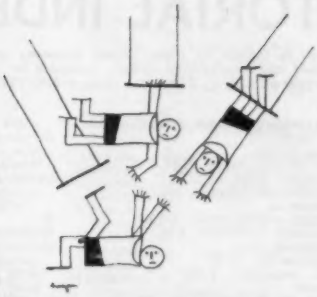
Chief, New Process Development

CASE 2179-P

PUNCH, SHEARING, AND BUNDLING

. . . Information would be appreciated on the automation of a punch and shearing machine, presently manually fed, which shears ¼ inch by 4 inch by 12 to 16 foot long steel strips into 4 inch long plates. An 11/16 inch hole is punched in the center of each plate. The plates are now manually grouped into bundles of ten plates. Information on the automation of the bundling phase would also be appreciated.

Senior Industrial Engineer



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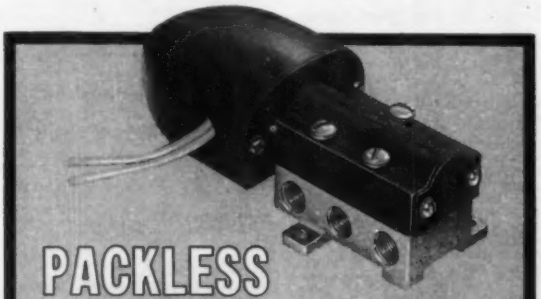

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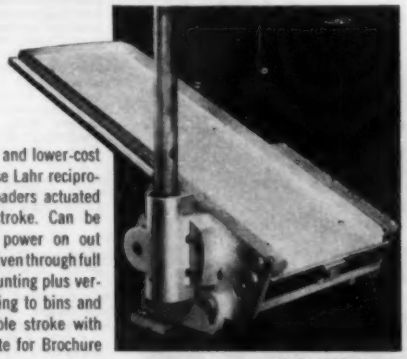

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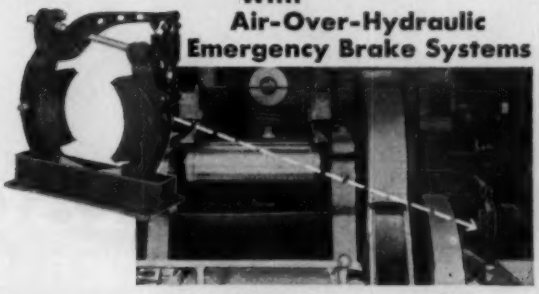

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Con Edison's power generating station in Astoria, Long Island, one of the largest of its kind in the world, supplies one-eighth of the power consumed by New York City's millions. An installation as vital as this naturally requires the utmost protection to insure efficient, uninterrupted operation—around the clock, around the calendar. And this is where Thomas A. Edison's OMNIGUARD system provides such an important contribution.

The bearings of Con Edison's auxiliary equipment, ranging from main boiler feed pumps to coal pulverizing mills, are monitored by Thomas A. Edison resistance temperature detectors which are connected to Omniguard monitors located in the main control room. If any one of the 200-plus bearings monitored begin to overheat, an alarm is sounded instantly, the trouble area is identified on the Omniguard panels, and prompt corrective action is taken. Thanks to Omniguard, trouble is detected *before* damage can be done—which not only increases bearing life but slashes Con Edison's over-all maintenance costs as well.

Any industry can enjoy the complete, continuous protection that Omniguard provides. For complete information on your particular requirements, call or write:

Thomas A. Edison Industries
INSTRUMENT DIVISION
86 LAKESIDE AVENUE, WEST ORANGE, N. J.

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